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The Veterinary Record

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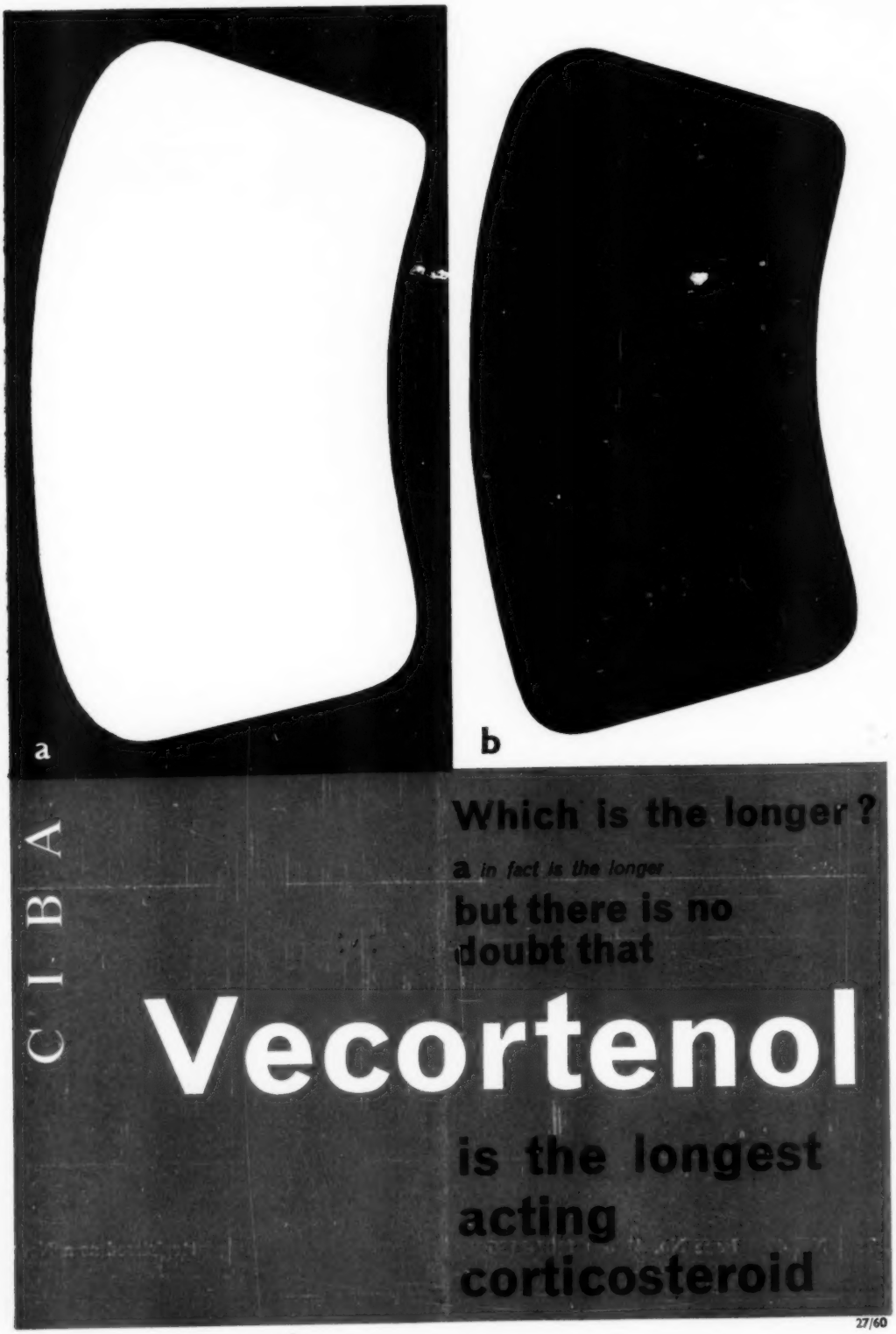
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Which is the longer?
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Vecortenol
is the longest
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27/60

THE VETERINARY RECORD

Founded by William Hunting, F.R.C.V.S., in 1888

Volume 72
No. 49

SATURDAY, DECEMBER 3rd, 1960

7 Mansfield Street,
London, W.1.
Museum 6541

The Victoria Veterinary Benevolent Fund

THIS Fund exists for the gratuitous relief, by means of monetary or other assistance, of necessitous and deserving members of the Royal College of Veterinary Surgeons whether subscribers to the Fund or not, and of the widows and other relatives of deceased members of the Royal College.

At this time of the year appeals for benevolence are frequent, and it is right and proper that members of our profession should spare a thought for their brethren and their dependants who have fallen on evil times through causes beyond their control. There is a tendency in this modern Welfare State to assume that our less fortunate fellows are provided for, and that no special efforts to come to their assistance are required by those in better circumstances. Unfortunately this is not so, more markedly in the case of the professional classes. To those who are engaged in the work of the Fund, each quarter brings its stories of sudden hardship, grief and sorrow, with a call for assistance which is invariably dealt with.

During the past year some fifty cases have received help amounting to £3,381, and this sum has been made up by subscription from members of the Fund, the wonderful contributions received from the Ladies' Guild, and investment income from the Clement Stephenson & Garnett Memorial Trust. It is a sad thought, however, that under 500 members of the profession are subscribers to the Fund. Considering the number on the Register of the Royal College, this is indeed cause for surprise, and is the more to be regretted when one looks at the magnificent efforts of the Ladies' Guild, who have this year raised over £1,000. We earnestly hope that non-subscribers will take to heart the example of these ladies and support the Fund forthwith.

There is often in life the feeling that "it can't happen to me"—but such optimism is damped in considering some of the cases the Fund is concerned with: a young widow whose husband was drowned in tragic circumstances, left with 3 small children to bring up and educate; another widow aged 37 with 7 children between the ages of 12 and 3 years; yet another widow whose husband died suddenly whilst at work and who is left with 2 children, the eldest of whom is 9 years old and blind. At the other extreme of life is a widow of 80, bedridden and in a nursing home, whose husband aged 86 died a few months ago. Her son is a permanent invalid, and a daughter contributes to the cost of her mother's living expenses to the best of her ability.

So many sad stories lie behind the appeals for help—ill health, bad luck and old age; and these are not good friends.

Quite recently an honorary official of the Fund visited an old lady, the widow of a veterinary surgeon who is receiving a small grant which enables her to present a brave face to the world at large. In her tiny house, scrupulously kept, one of her most treasured possessions was her late husband's brass plate, and it was with great pride that she spoke of him as a member of a great profession.

May we appeal most strongly to our readers for further support and encouragement in the good work which is being done? To younger members we would appeal especially. They are at a stage when making provision for their dependants is not easy, and the life of a veterinary surgeon is sometimes beset by unusual hazards. They should regard it as a bounden duty to become members of the Fund; it costs but ten shillings and sixpence a year.

One has seen some of our brilliant professional men at the peak of their careers struck down by death or disease before time had elapsed for them to make any substantial provision for their families. Help given to the Fund in such cases may perhaps be returned a thousandfold.

The Christmas Gift Fund makes it possible to provide a little additional help and bring some of the comforts of life to those who cannot afford any further expenditure from their meagre budget. Will every reader please help? By doing so he or she will be benefiting, at a most appropriate time, those who have fallen by the way. The secretary of the Fund will be pleased to supply all particulars, and collecting boxes are available if readers care to apply for them.

It has been said that every man is the architect of his own fortune; whilst this may be so, can we shrug aside our moral responsibilities to those in the profession and their dependants who, through no fault of their own find only the shadow and not the substance?

Congress Paper

Small Animal Radiography*

BY

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SUMMARY.—Radiography is a specialised form of photography which presents many technical problems.

The subject has been divided so that the various parts of the subject are discussed separately under the following headings :—

X-ray production; exposure calculation; image formation and recording; film processing; processing faults, and X-ray protection.

It is emphasised that since all of these processes are employed in radiography, each must be understood if satisfactory radiographs are to be obtained.

The very great importance of X-ray protection to the veterinary surgeon, his staff and the animal owner is indicated and the various factors of greatest importance stressed.

THE use of X-ray procedures for diagnostic purposes is constantly increasing in veterinary clinical work, largely in response to public demand.

The extent of the benefit by which radiology can contribute to diagnosis depends on the veterinary surgeon's knowledge of the technical factors involved, and for those who have not as yet studied this subject extensively it is hoped that this paper will be of some value.

X-Rays and X-Ray Production

X-rays form a small part of the electro-magnetic spectrum, which includes :—

Electric; Radio; Television; Infra-Red; Visible Light; Ultra Violet; X-Rays; Gamma Rays, and Cosmic Rays, in order of diminishing wave length.

The short wave length of X-rays (10 – $\frac{1}{10}$ Angstrom units), as compared with visible light (app. 10,000 A°), makes it possible for them to penetrate tissues.

X-Ray Production

X-rays are produced when electrons, travelling at high speed, collide with matter in any form. The X-ray tube is designed to promote this activity and is constructed like a large size radio valve. It consists basically of a sealed glass envelope pumped out to a very high vacuum and enclosing 2 structures: the cathode and the anode. (Fig. 1.)

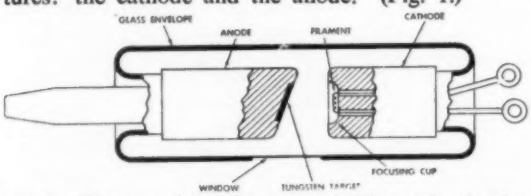


FIG. 1.—Diagram of a stationary anode X-ray tube showing relation of anode and cathode.

The Cathode—consists of a filament which can be heated by an electric current so that it glows and *emits electrons.* These form the electron beam which serves to carry the tube current across the tube during "exposures.". The electrons are focused on to the appropriate area on the anode by a "focusing cup" in the cathode. (Fig. 2.)

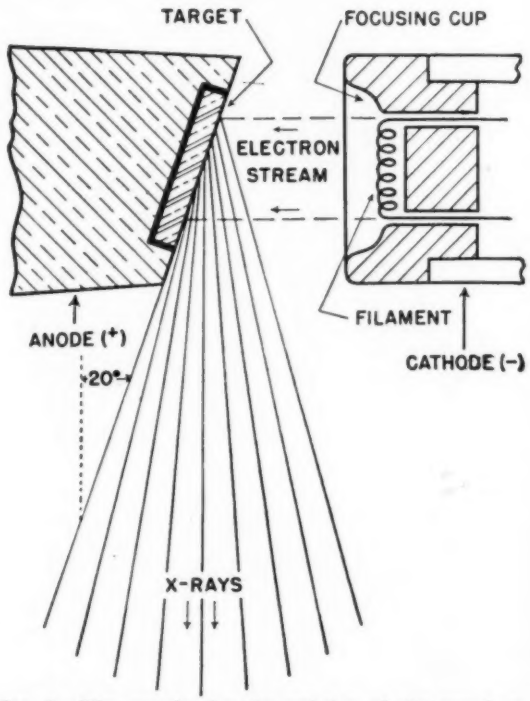


FIG. 2.—Diagram showing the emission of electrons from the heated filament and the resulting production of X-rays from the focal spot of the anode.

The Anode—is usually constructed of copper and carries on its inner end a block of tungsten, which serves as the "target" for the electron beam. The actual area which is bombarded is called the focal spot. It is the source of X-rays, and also of much waste heat.

The anode is constructed to promote the rapid dispersal of the heat generated; but it is the production of this heat which limits the duration of exposures.

The focal spot size is important since the smaller the spot, the sharper the image will be. Unfortunately very small focal spots are particularly liable

* Paper presented to the Annual Congress of the British Veterinary Association in Glasgow on Friday, September 2nd, 1960.

to heat damage. Two methods are employed to effect a compromise between those conflicting factors.

The principle of line focus is used; in this if a rectangular area is viewed from an angle of 20° it will appear to be square and so it is possible to use a focal spot which is 3 times as long as it is wide without loss of detail in the final image. (Fig. 3.)

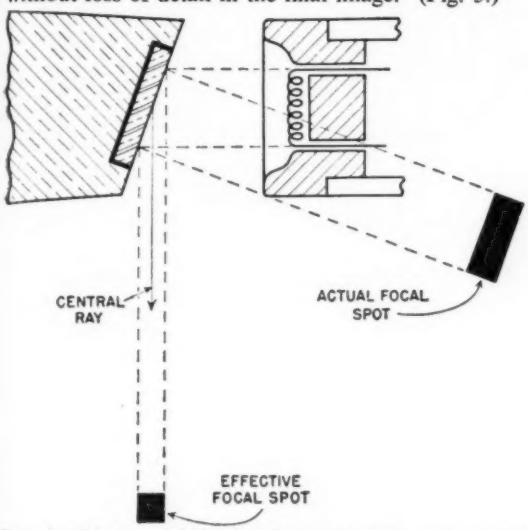


FIG. 3.—Diagram of the line-focus principle. The anode face forms an angle of 20° with the cathode face and the projected area of the focal spot as viewed from the direction of the central ray is only a small part of the actual area of bombardment.

In large, high powered machines, the stationary anode is replaced by a rotating anode which has a wheel that carries a ring of tungsten to act as the target. The wheel is made to revolve during exposures and so that actual target area is constantly changed and it can withstand much greater amounts of bombardment without risk of melting.

Operation of the X-Ray Tube

The current passes across the X-ray tube only during the period of an actual exposure. It is carried by the electrons which have been emitted by the filament and so is proportional to the number of electrons which are available and this in turn is controlled by the filament heating current.

The tube current is measured in milliamperes ($1 \text{ ma.} = \frac{1}{1000}$ ampere). *Thus, the "quantity" of X-rays produced is proportional to the tube current* (*ma*) which in turn is proportional to the filament current. If the number of electrons available doubles, the tube current (ma) doubles and the X-ray production doubles.

The electrons are impelled across the tube at high speed by the application of a very high difference of potential between the cathode and the anode. This high voltage is expressed as kilovoltage —kV. (1 kV. = 1000 volts), and increase in kV. will increase the acceleration of the electrons across the tube and will increase the electron-target impact.

The higher the kV., the faster the electrons travel, the harder the impact and the shorter the wave length (more penetrating) of the X-rays produced. So that *the "quality" of the X-rays produced is controlled by the kilovoltage* (*kV*).

Mains Current and Rectification

The current used to energise the X-ray generation is mains line, 50 cycle, alternating current which reaches its maximum difference of potential and falls back to zero twice within each complete cycle. (Fig. 4.) Thus the X-ray tube receives a series of voltage

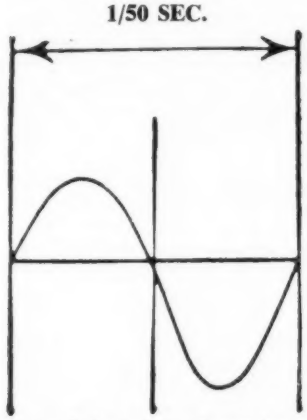


FIG. 4.—Diagram of the voltage fluctuation which occurs during each complete cycle with mains alternating current. The complete cycle occurs fifty times per second.

pulses, one for each useful peak, and so produces X-rays in bursts. Because of these surges of voltage across the tube, the X-rays produced are not all of the same wavelength but form a spectrum of X-rays, the most important of which are the short rays produced during the period of greatest difference of potential.

Mains, 50 cycle current, exhibits a reversal in polarity twice in each complete cycle and this is reflected in the behaviour and construction of X-ray generators.

Portable and mobile generators are usually self-rectified (non-rectified) machines, in which the X-ray tube will only pass current for one half of each cycle because the electrons are negatively charged and will only be attracted to the anode when it is positive in respect of the cathode. (Fig. 5.) These non-

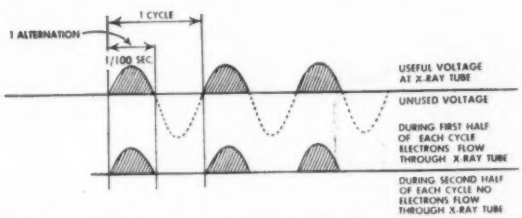

1 CYCLE
1 ALTERNATION
1/100 SEC.
USEFUL VOLTAGE AT X-RAY TUBE
UNUSED VOLTAGE
DURING FIRST HALF OF EACH CYCLE ELECTRONS FLOW THROUGH X-RAY TUBE
DURING SECOND HALF OF EACH CYCLE NO ELECTRONS FLOW THROUGH X-RAY TUBE

FIG. 5.—Diagram of the voltage wave form of the current passed by a non-rectified X-ray generator.

rectified machines must have their output restricted to prevent the possibility of "flashback" occurring, as might happen if the anode becomes overheated and becomes itself a source of electrons.

Larger machines where higher output is required, have specially constructed rectifiers which permit the a.c. to pass on both halves of the cycle because the anode is kept positive in respect of the cathode during both halves of the cycle and so the possibility of flashback is minimised and larger loads can be applied.

Calculating the Exposure

The variable factors which contribute to an exposure are interrelated and can be adjusted to meet any requirement. If, however, conditions demand that one factor should be altered so as to give a more satisfactory film, *e.g.* the kV. may be raised to give more penetration; the other factors may also require to be changed so that the film will not be excessively blackened.

For convenience various factors will be considered in pairs: —

Milliamp—Time Relation

The tube current (ma.) is proportional to the amount of X-ray production.

This current must have a time factor (seconds), and since for any one ma.-setting, a unit of time will produce a given "quantity" of X-rays, alteration in the duration of the exposure will directly affect the total available X-rays.

This is most conveniently expressed as a single factor which is a multiple of ma. and time—milliamp-seconds (ma.s.), *e.g.* 5 ma. for 1 sec. = 5 ma.s. = 20 ma. for 0.25 sec.

Effect of Tube to Film Distance

X-rays obey the light laws and pass in straight paths from their source; they also diverge from each other so that the area of coverage increases with distance and the intensity of the beam decreases with distance. (Fig. 6.)

The X-ray beam intensity varies inversely with the square of the distance. This means that the radiation which covers a given area at distance D from the focal spot will cover four times this area at twice the original distance 2D.

Also if the intensity of the beam at D is 1; its intensity at 2D will be $\frac{1}{4}$.

Milliamp-Time—Distance Relations

When the focal-film distance is altered it has a profound effect on the intensity of the X-ray beam and this must be compensated for by altering either time of exposure or the ma. value (*i.e.* alter ma.s.), if a proper exposure at the new distance is to be made.

To calculate the actual change in values required the following formula may be used: —

$$\frac{D\ (new)^2}{D\ (old)^2} = \frac{Ma.s.\ (new)}{Ma.s.\ (old)}$$

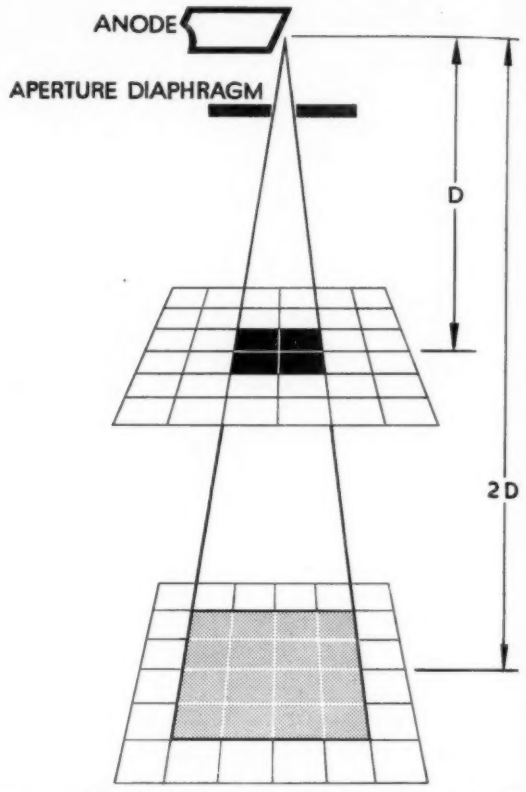


FIG. 6.—Diagram showing the effect of alteration in focus-film distance on the (a) intensity and (b) coverage of the X-ray beam.

The following Table I may be used in place of calculation, where both original and new distances are known by reading across from the original value in the left column to the box under the new value, as shown across the top. The number obtained is the factor by which the original ma.s. value should be multiplied so as to give the same intensity of X-ray beam at the film, *e.g.*, original values 10 ma.s. at 30″ = 10 × 2.56 at 48″.

Influence of Intensifying Screens on Exposure

Intensifying screens are used, in cassettes, to convert the X-ray beam into a bluish visible light, to which the appropriate (screen-type) film is specially sensitive. This permits the radiographic examination of thick areas of the body, which would otherwise require an excessively long exposure (v. also under recording medium).

Relation between Kilovoltage and Time

Increase in the kVp. of a tube setting will cause the production of more penetrating rays, with the result that more rays will pass through to the film and if the overall blackening of the plate is to remain constant the time of the exposure should be altered.

TABLE I

Original total film distance in inches	New focal film distance (inches)								
	12	16	20	25	30	36	40	48	60
12	1·00	1·77	2·77	4·34	6·21	9·00	11·11	16·00	25·00
16	0·56	1·00	1·11	2·44	3·51	5·06	6·25	9·00	14·06
20	0·36	0·64	1·00	1·56	2·25	3·22	4·00	5·76	9·00
25	0·23	0·41	0·64	1·00	1·44	2·07	2·56	3·68	5·76
30	0·16	0·28	0·44	0·69	1·00	1·44	1·77	2·56	4·00
36	0·11	0·19	0·31	0·48	0·69	1·00	1·23	1·77	2·77
40	0·08	0·16	0·25	0·39	0·56	0·81	1·00	1·44	2·25
48	0·06	0·11	0·17	0·27	0·39	0·59	0·69	1·00	1·56
60	0·04	0·07	0·11	0·17	0·25	0·36	0·44	0·64	1·00

The following Table II gives the correction factors.

TABLE II

Time	Kilovolt	
	With screens	Without screens
Decrease per cent.	*Increase per cent.*	
25	7	15
50	20	40
75	50	100
Increase per cent.	*Decrease per cent.*	
25	5	10
50	10	18
75	13	25
100	16	30

The Practice of Exposure Calculation

It is usual when setting a machine for a given exposure to employ a setting which has been previously found, by trial, to give satisfactory results. The factors which must be listed for any such exposure are: —mas. (milliamp. × time): kV.: film type: use of screens: · focal film distance: use of grid. This group of factors can be readily listed for areas of the body which show only relatively small variations in thickness (*e.g.*, extremities) but for the parts of the trunk where total thickness is variable, this must be taken into account.

Knowledge of the relationship of the factors will permit the appropriate adjustment to improve film quality.

The following Table may be used as a guide: —

Positioning in Radiography

The final radiograph which is available for inspection is a 2-dimensional representation of a 3-dimensional object, since all the structures which have been traversed by the X-ray beam affect it. This results in the superimposition of a number of images, each produced at a different level in the object, one on top of the other. It is usual, therefore, to make two exposures of any object, so arranged that the projections are at right angles to each other. Usually an antero-posterior and a lateral projection are employed. By examining the two films and comparing them it is possible to obtain a great deal more information than is available from one film only.

For certain special purposes accurate positioning is of the greatest importance, for example, the detection of hip dysplasia is rendered very much less certain and more difficult if the dog is not positioned so that and accurate ventro-dorsal projection of the pelvis is obtained.

Positioning of the patient can assist in arranging that structures which will normally be superimposed, are separated—*e.g.*, a lateral projection of a hip can be improved by abducting the opposite (upper) thigh so that only the hip being examined is visualised in its original position.

Improper positioning of the patient will cause projection distortions—*e.g.*, gross fore-shortening of a long bone—and such effects must be borne in mind when examining a plate. Alterations in position of the patient also alter the thickness of the part which

TABLE III

	Dog					Cat				
	Film type	F-F distance	kV.	mas	Grid	Film type	F-F distance	kV.	mas	Grid
Foreleg	Non-screen	36	55–60	10	–	Non-screen	36	50–55	8	–
Elbows	N.S.	36	60–65	10	–	N.S.	36	50–55	8	–
Humerus	Screen	36	60–65	10	+	N.S.	36	50–55	10	–
Hock	N.S.	36	60	10	–	N.S.	36	50	10	–
Tibia	N.S.	36	60–65	10	–	N.S.	36	55	10	–
Stifle...	N.S.	36	70	10	–	N.S.	36	50	10	–
	Sc.	36	55	8	–					
Hip	Sc.	38	70–75	10–25	+	Sc.	36	55	10	+
Skull	Sc.	38	70–80	20	+	Sc.	38	65–70	10	+
Cervical spine ...	Sc.	38	80	24	+	Sc.	38	65	10	+
Thoracic spine ...	Sc.	38	80	20	+	Sc.	38	65	10	+
Lumbar spine ...	Sc.	38	85	20	+	Sc.	38	65–70	10	+
Pelvis	Sc.	38	80	24	+	Sc.	38	70–75	10	+
Chest	Sc.	38	70–80	12–20	+	Sc.	38	50–60	4–12	+
Abdomen	Sc.	38	70–85	15–20	+	Sc.	38	50–60	4–12	+

is to be traversed and this must be taken into account when setting the exposure factors.

X-Ray Image Formation and the Recording Medium

X-rays pass in straight lines from their source, unless stopped by some absorber. Absorption increases in direct ratio to the increase of the atomic number of the matter traversed. The most efficient absorber is lead and for this reason it is used to shield the X-ray tube and also as protective clothing.

X-rays penetrate tissues because of their short wavelength, but since the X-ray beam is composed of a "spectrum of rays" and since the different body organs have varying X-ray absorbing properties only those that do, finally traverse the body form the image, which is, in fact, a shadow image produced by the absorption of the X-ray beam by all the structures that have been traversed. This image is recorded on X-ray film and the whole process is basically a specialised type of photography.

The Film

X-ray film is capable of recording either the X-ray image directly; or the blue-light image which is produced by the intensifying screens.

These 2 types of film are referred to as non-screen film and screen type film. The non-screen film is used almost exclusively for work on extremities where adequate exposure can be achieved with relatively brief times. (These films should *not* be used with intensifying screens since they are sensitive to X-rays —not to blue light).

There are 2 main grades of screen type film. Standard and high speed film; the latter has a "faster emulsion" and requires a smaller exposure to cause satisfactory "blackening".

Film type	Speed	Contrast	Use of screen
Non-screen film	Moderately fast	Very high	—
Screen type			
Standard ...	Fast	High	+
High speed ...	Very fast	Good	+

The film is composed of a base of gelatin, which is coated on both sides with sensitive emulsion. On exposure, a change occurs in the physical structure of the emulsion and this is known as the latent image, which can only be detected following processing of the film.

The use of double emulsion has a dual effect: —it increases the speed of the film and also increases the contrast (vi.) between different areas of the image.

Intensifying Screens

Consist of thin layers of calcium tungstate crystals on the face of a support.

The crystals fluoresce when they are irradiated and the fluorescence is proportional to the intensity of the X-ray beam in that area. This produces an "intensification" of the image which is then recorded by the film.

The size of the fluorescent crystals is directly proportional to the degree of image intensification, but this increase in crystal size causes loss of image sharpness since each crystal acts as an independent source of light. In practice a crystal size 0.015 mm. provides a satisfactory compromise. (Fig. 7.)

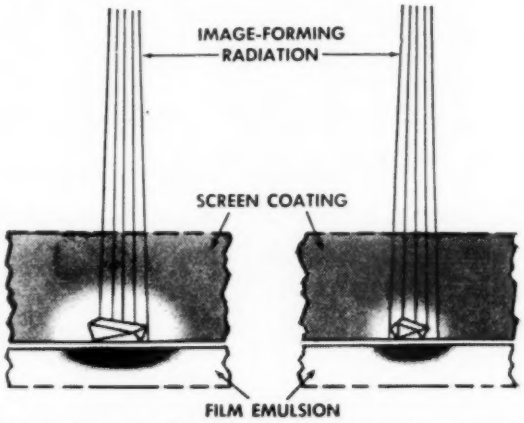


FIG. 7.—Diagram illustrating the effect of calcium tungstate crystals in intensifying screens. Left—large crystals tend to produce image unsharpness. Right—smaller crystals cause less detail loss.

Screens are placed on both sides of the X-ray film in the cassette so that any X-rays which pass through the front screen and the film will cause fluorescence on the back screen and will help in producing the final image. (Fig. 8.)

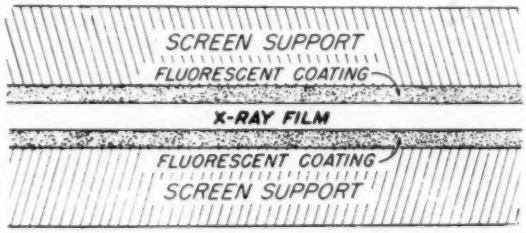


FIG. 8.—Diagram of a cross-section of intensifying screens and X-ray film showing close contact of screen and film both back and front.

Any marks on the surface of an intensifying screen will prevent the light produced from reaching the film and will therefore be seen as a white mark on the film.

Density

The developed image, as seen on the X-ray plate, is composed of grains of metallic silver which are distributed throughout the 2 layers of emulsion. The X-ray plate is examined by transmitted light from a viewer.

The density of the image is the ratio of the incident light to the transmitted light and it is the variations in this density that occurs from place to place on the plate that forms the image.

If the plate has insufficient density, the image will not be visible because of the excessive light transmission; and conversely if the density is excessive, no light from the illuminator will pass and so the plate will again be valueless from the diagnostic standpoint. (Fig. 9.)

Contrast

The relative brightness of the different parts of the image as seen on the illuminator is called the radiographic contrast. This is a product of two factors: —

(1) *Film Contrast*—This is an inherent characteristic of the film emulsion and is controlled only by the processing. The film is manufactured so as to increase the contrast of the screen image by slightly more than double and this is one of the reasons why much more can be seen on examining a radiograph than on viewing the fluorescent screen directly. The lighting used for X-ray plate viewing is also much more suited to human vision and is the other important factor. (Under optimal conditions the human can detect 2 per cent. differences in contrast: under poor conditions, *e.g.*, fluoroscopy—up to 20 or even 30 per cent. differences may be required.) Screen-type film exposed with screens has greater contrast than the same films exposed without screens, because of the greater sensitivity of the film to the blue light given off by the screens.

(2) *Subject Contrast*—is the result of the differing absorption of the X-ray by the various tissues of the patient. This can be controlled by varying the wavelength of the X-ray beam, which is achieved by adjusting the Kilovolt setting. Increase in kV. setting will reduce the contrast for a given exposure because it will cause a more even penetration of the entire subject. (Fig. 10.)

FACTORS WHICH AFFECT CONTRAST

Increased by	Decreased by
Lowering kV.	Raising kV.
Elimination of scatter	Presence of excessive scatter
Use of intensifying screens	No screens
Use of high-contrast film (*e.g.* non-screen film where possible)	Use of very fast film (*e.g.* use of screen-type film for non-screen work)
Agitation in developer	Either markedly shortened or excessive lengthening of development time

Detail

The purpose of radiography is to present to the observer the maximum amount of information on the part being examined. Whether a radiograph is useful or not depends on the detail that is visible in the final film.

The detail depends on the sharpness (definition) of the image and on the radiographic contrast. If the boundaries of a structure are sharp and are clearly delineated and if the subject contrast is sufficient to produce a difference in the associated film image density then the detailed visibility is good.

Factors which affect detail

(1) *Exposure factors*

These must produce satisfactory density of the film and must also allow for reasonably high subject contrast.

(2) *Scattered radiation*

Some of the X-rays in the primary beam neither pass through to the film directly nor are absorbed, but become deflected so that they disperse in all directions. This is referred to as scattered radiation (secondary radiation).

In this way the object, because it produces scatter, is a source of unwanted radiation which will contribute to the density of the film, but, because these deflected rays land without relation to the position of the structures being examined they do not contribute to the image formation. In fact, quite the opposite effect, an overall loss of contrast and detail is produced.

The most effective method of eliminating scatter is to use a grid which is a composite sheet built up of alternate strips of lead and X-ray transparent material so arranged that they are in line with the primary beam when the focal spot is centred over the grid. This arrangement permits the lead strips to absorb any rays which are travelling obliquely to the primary beam (Figs. 11 & 12). The efficiency

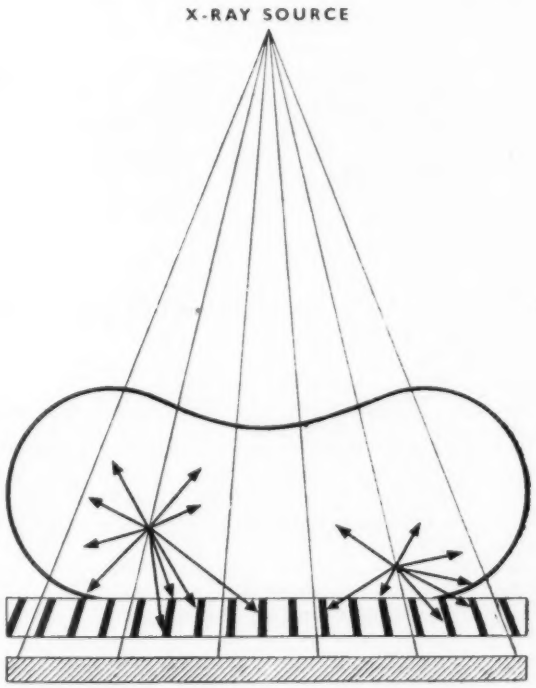


FIG. 11.—Diagram of the use of a grid for the reduction of scattered radiation.

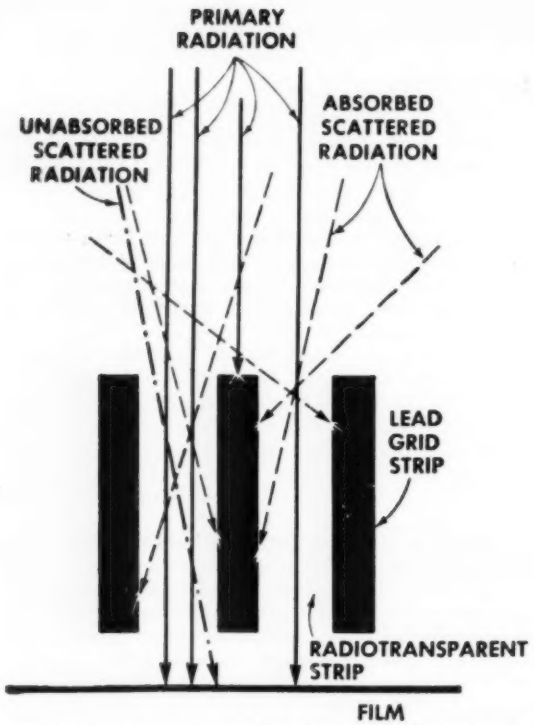


FIG. 12.—Diagram of a small section of a grid showing the manner in which a large proportion of the scattered radiation is absorbed and the image forming rays pass through to the film.

of the grid depends on the ratio of the depth of the lead strips to the width of the spaces between them. This is the "grid-ratio" (*e.g.*, if the depth is 6 times the width the ratio is 6: 1). The greater the ratio the more efficient the grid.

Because of the loss of part of the intensity of the beam, due to the effect of the grid, the exposure must be increased to maintain satisfactory film density when a grid is used.

Stationary grids must be made with very fine lead strips so that the image of these strips does not interfere excessively with the main image. These grids have their slats set at an angle, so that the rays of the primary beam will pass directly through between them at all parts of the grid, if the appropriate focal film distance is employed. A mechanical device may be employed to move the grid across the film during exposure—a Potter-Buckey, and recently an oscillating mechanism has been devised to have the same effect by a slightly different method. These moving grids have the advantage over stationary grids in that they do not leave lines across the plate.

Another method of minimising scatter is the restricting of the primary beam so that it covers only the area which is to be examined. This prevents scatter from occurring from adjacent parts of the body.

This is achieved by the use of cones or diaphragms, which prevent the primary beam from spreading out in its normal fashion and directs the beam to the area where it is required, so that the surrounding tissues are not irradiated and so do not act as a source of scatter. (Fig. 13.) This is also of great

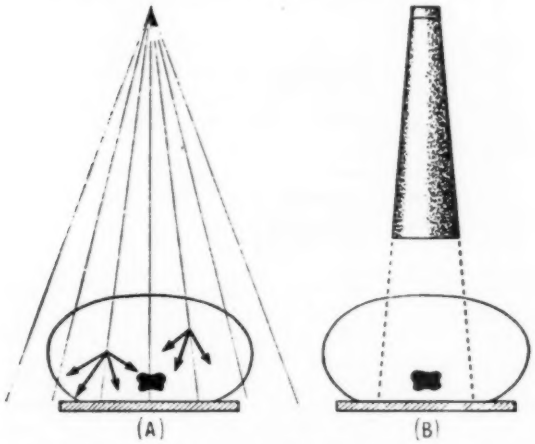


FIG. 13.—Diagram of scatter within an irradiated body (A) and the use of a cone to limit the area of irradiation and so reduce the total amount of tissue acting as a source of scatter (B).

value in protective measures in relation to the radiographer.

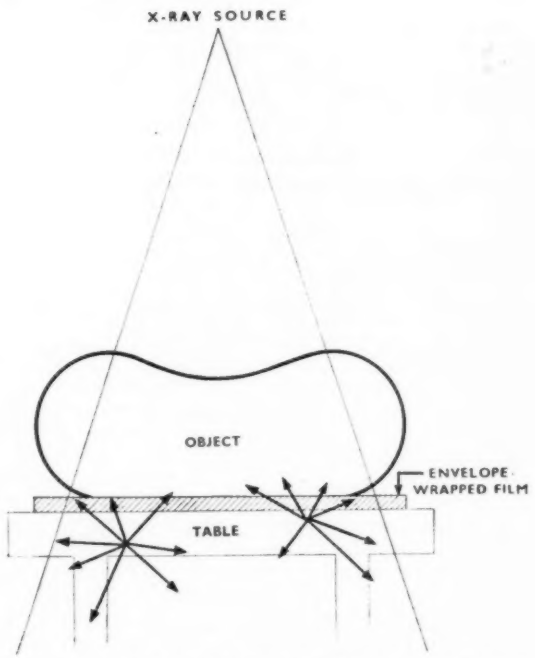


FIG. 14.—Diagram of the effect of back-scatter from table top when using envelope-wrapped film.

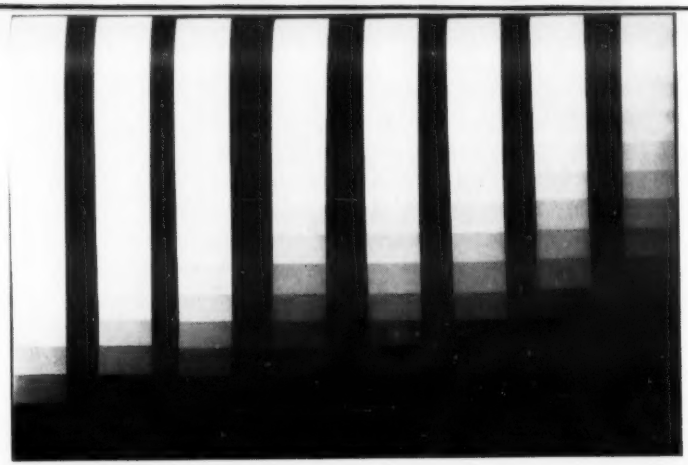


FIG. 9.—Eight radiographs of an aluminium step wedge, to demonstrate the effect of exposure on film density. All exposures were made at 60 kV but the mas. value was increased, from left to right as follows: 10, 12, 14, 16, 18, 20, 24, and 30 mas. respectively.

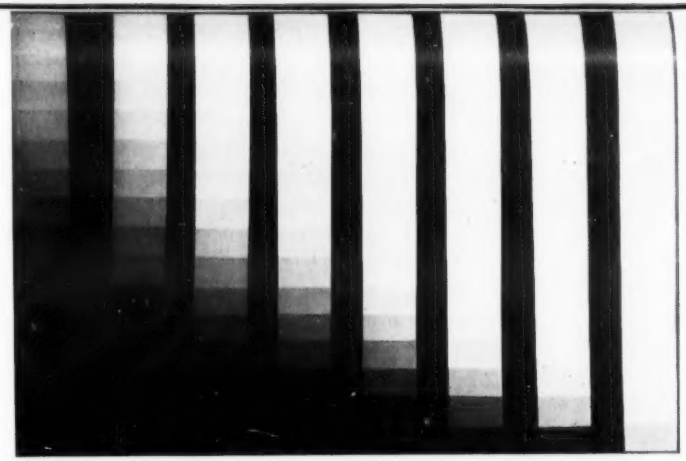


FIG. 10.—Eight radiographs of an aluminium step wedge, to demonstrate the effect of kilovoltage on subject contrast. All exposures were given 10 mas. but the kV was increased from right to left as follows: 40, 45, 50, 55, 60, 65, 70, and 75 kV, respectively. Note: that the lower kV values produce high (short scale) contrast and the higher kV gives low (long scale) contrast. Note also that the higher kV values cause a marked increase in film density as a result of greater object penetration.

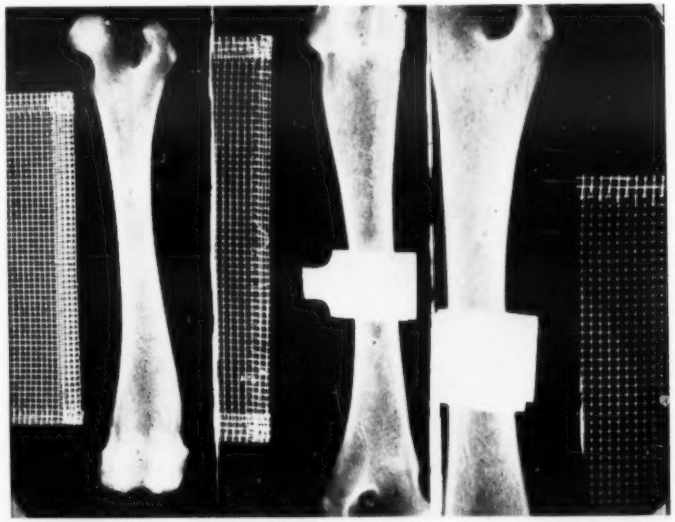


FIG. 17.—Three radiographs taken of a dog's femur and of a piece of coarse wire gauze at increasing object-film distances. Left—bone and gauze in contact with paper envelope. Centre—3″ object-film distance. Right—6″ object-film distance. All radiographs taken with 36″ focal-film distance. Note: Both gross blurring and gross magnification distortion of the image occurs at the greater object-film distances.

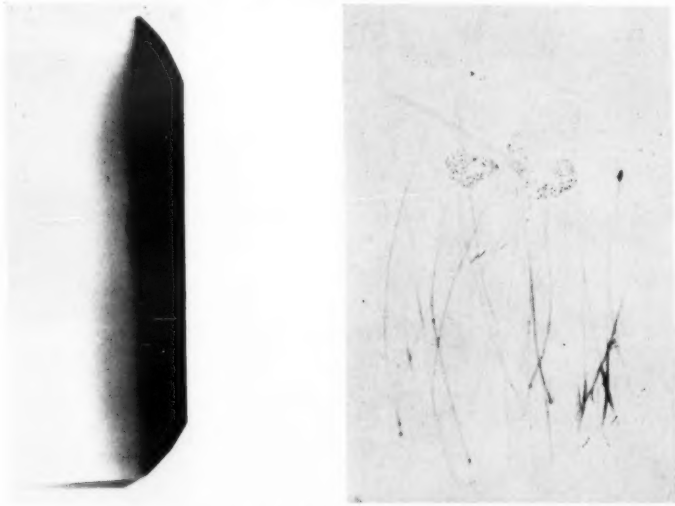
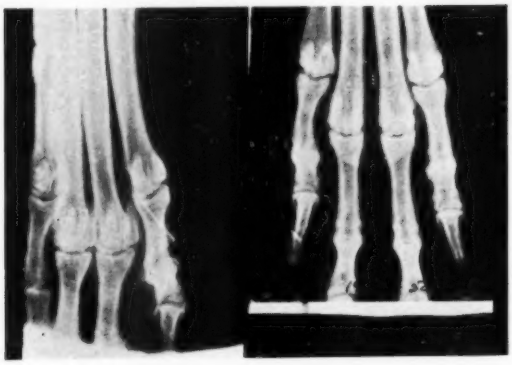


FIG. 18.—Fogging of one end of film caused by exposure to light when film hopper opened accidentally. The films had been stacked with the open end of the paper wrapper uppermost.

FIG. 19.—Pressure marks produced by scoring envelope-wrapped unexposed film.



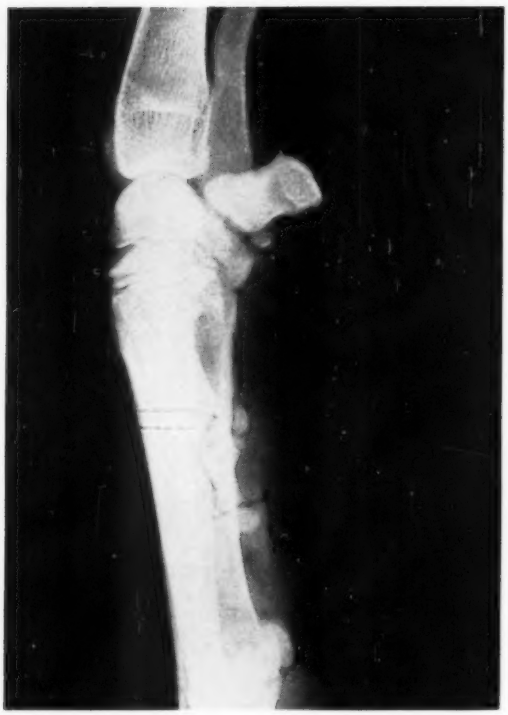


FIG. 20.—Radiographs of two dogs' paws showing typical *pre-exposure* scratch-pressure marks caused by the dogs' claws.

FIG. 21.—Lateral radiograph of a dog's carpus and foot showing a *post-exposure* scratch-pressure mark over the metacarpus.

FIG. 22.—Radiograph of a dog's shoulder showing artefacts caused by dirt on intensifying screens and also by a piece of paper and two hairs in the cassette.

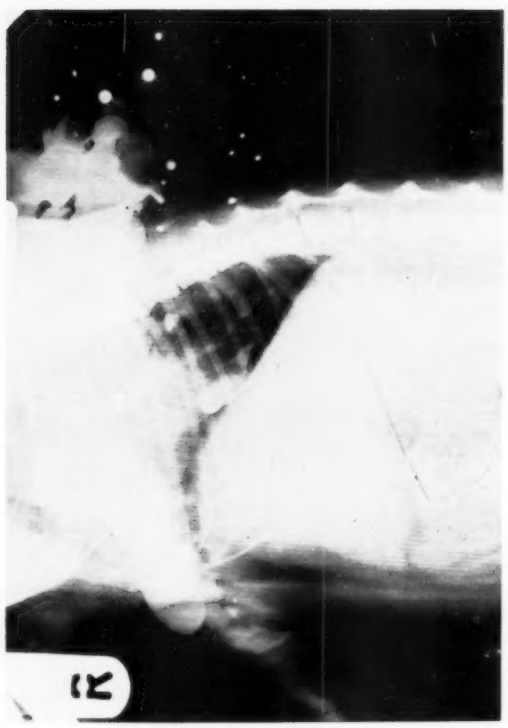


FIG. 23.—Radiograph of a dog's chest ruined by gross fixer splash at one end.

A second source of scattered radiation is the table top and this is referred to as " back scatter " which can be prevented by laying the film on a layer of X-ray absorbing material such as lead. (Fig. 14.) Most cassette manufacturers incorporate a sheet of lead in the backing of cassettes, but if paper wrapped non-screen film is used it is necessary to lay the film on a sheet of lead.

(3) *Intensifying Screens*

Increase the speed and contrast of the film and permit satisfactory films to be made of thick areas.

In areas where non-screen films can be used (*e.g.*, extremities) the detail visibility will be improved by using this type of film. In thicker areas intensifying screens must be used to reduce the exposure factors, but because intensifying screens act as multiple point sources of light they are a potential source of slight light scatter; this effect can be minimised by good film-screen contact. (Fig. 15.)

(4) *Focal spot size*

The smaller the focal spot size, the sharper the image, and *vice versa*. This, of course, is an inherent feature of the design of the particular machine and it can be varied only on certain large machines. (Fig. 16.)

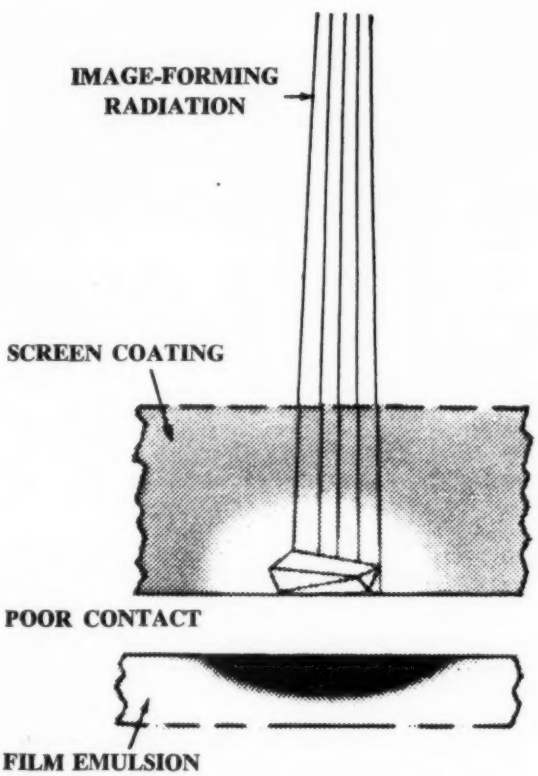


FIG. 15.—Diagram showing why poor contact between film and screens produces unsharpness of the image.

(5) *Focal-Film Distance*

The longer the focal-film distance the more nearly parallel are the rays of the X-ray beam and the sharper the image.

(6) *Object—Film Distance*

The smaller the object film distance the less blurring of the image will occur. (Figs. 16 & 17.)

(7) *Movement*

Both horizontal and vertical movement during exposure will cause blurring. Vertical movement of the subject is most commonly caused by respiration.

(8) *Magnification*

Since the X-ray beam is produced from a small source and is diverging some slight magnification of the image is always produced. The degree of this magnification is determined by the ratio of focal-film to object-film distances. (Figs. 16 & 17.)

The following Table gives the range of magnification obtained under differing circumstances: —

TABLE IV

PERCENTAGE MAGNIFICATION

Object film distance inches	Focal-film distance						
	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.
1	4·34	2·86	2·13	1·69	1·41	1·20	1·05
2	9·05	5·88	4·35	3·45	2·85	2·44	2·13
3	14·29	9·05	6·67	5·26	4·35	3·70	3·24
4	20·00	12·50	9·05	7·14	5·88	5·00	4·35
5	26·31	16·13	11·64	9·09	7·46	6·32	5·49
6	33·33	20·0	14·29	11·11	9·09	7·69	6·67
7	41·18	24·14	17·07	13·27	10·77	9·11	7·86
8	50·0	28·57	20·0	15·28	12·49	10·53	9·09

Film Processing

Since the quality of the radiograph depends as much on processing as on the original exposure, it is obvious that processing should be carried out with as much care as the original exposure.

Briefly the various solutions are: —

1. *The Developer* is a chemical solution which converts the invisible (latent) image into the visible one, composed of minute grains of metallic silver.

The developer consists of 4 main ingredients dissolved in water, they are: —

(a) The developing agent—which converts the silver halide grain, affected by exposure, to black silver;
(b) The accelerator—an alkali to promote the developer action.
(c) The preservative—to prevent oxidation of the developer by air.
(d) The restrainer—which prevents the developer from acting on the non-exposed silver halide grains.

2. *The Rinse*: —This is used next to remove as much of the developer as possible from the film between the stages of development and fixing. If this

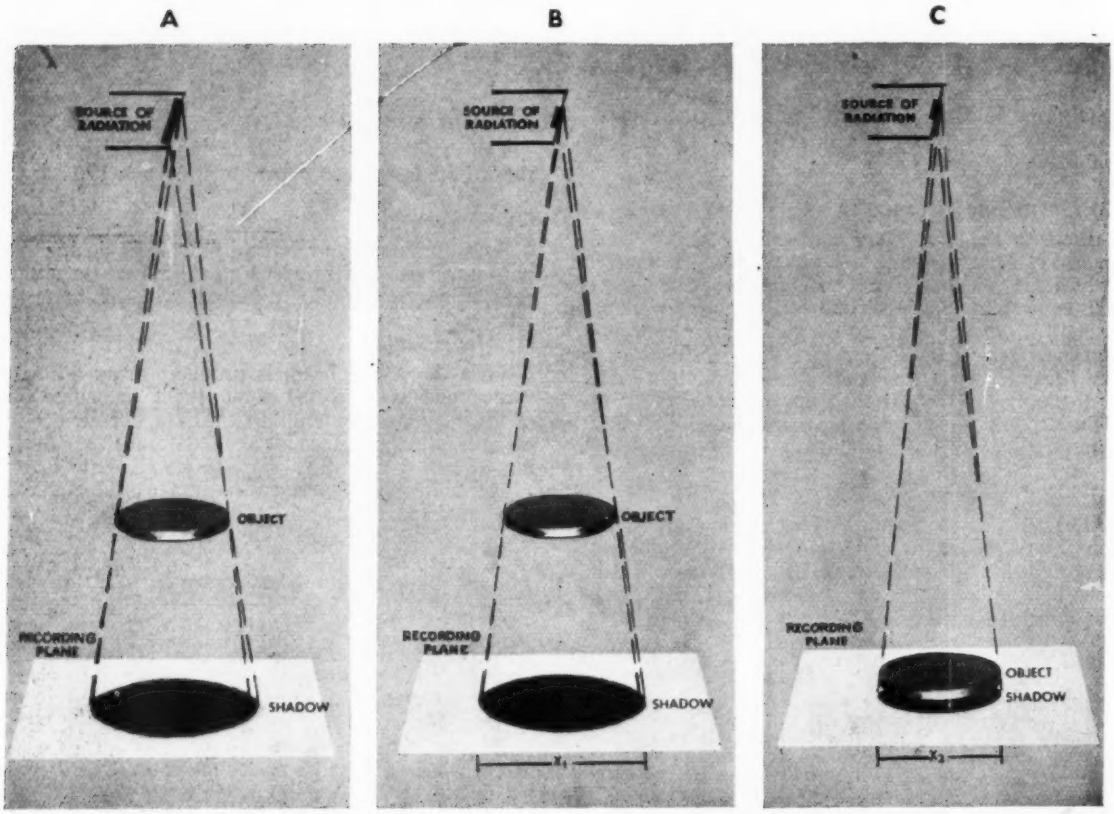


FIG. 16.—Diagram showing geometrical effects on image sharpness: A, Unsharpness caused by large focal spot and large object-film distance. B, improvement caused by small focal spot. Unsharpness now due to large object-film distance. C, Improved sharpness results from small object- film distance. Note Magnification effect (X_1) seen in B as compared with more accurate size (X_2) in C.

step is omitted, the alkali in the developer which is carried over will rapidly neutralise the fixer.

3. *The Fixer*: —This clears the film by removing the undeveloped silver halide from the emulsion. This prevents the film from any further reaction to light. Also the gelatin coating is hardened so that it will be less liable to scratch damage.

The chemicals in the fixer are: —

(a) The clearing agent—which dissolves out the remaining silver halide from the emulsion.

(b) The acidifier—which counteracts any alkali carried over from the developer.

(c) The hardener—which prevents excessive softening or swelling of the gelatin while washing.

(d) The preservative—which prevents decomposition of the fixer.

In order to obtain satisfactory processing results it is necessary to employ a suitable routine procedure. If constant processing factors are not adhered to, the reproduction of the film will be very difficult, because a new set of variables have been added in addition to those involved in the exposure.

When the film is placed in any solution it should be moved up and down several times to prevent stagnation of the solution against the film or the possible formation of " air bells."

Processing Procedure

All processing should be carried out within a fairly small range of temperatures (60°–75° F.) and if at all possible, the same temperature should be used at all times; a temperature of 68° F. is recommended by most film manufacturers.

The length of time that the film is left in the developing tank is determined primarily by the temperature of the solution.

This is referred to as the Time-Temperature factor.

This factor can be maintained at a fixed value if the activity of the solution is maintained by the addition of X-ray developer replenisher to maintain the activity of the solution. This is done by " topping up " the developer tank with replenisher to a given level.

Under this system the solution may be maintained for approximately 3 months, when it should be renewed.

DEVELOPMENT DATA FOR REPLENISHER SYSTEM

Temperature of solution, ° F.	Screen-type film		Non-screen film	
	Maximum speed, minutes	Normal speed and contrast, minutes	Maximum speed and contrast, minutes	Normal speed and contrast, minutes
60	9	5½	16	8½
62	7½	4¾	13	7½
64	6½	4	11	6½
66	5½	3½	9½	5¾
68	5	3	8	5
70	4¼	2½	7	4½
72	3¾	2¼	6½	3¾
74	3¼	2	5¾	3½
75	3	1¾	5½	3¼

It is also possible to use the "exhaustion system" in which the developer level in the tank is maintained by the addition of more developer. Under this system the entire solution becomes gradually exhausted and it is necessary to adjust the processing time according to the number of films that have been developed.

DEVELOPMENT DATA FOR EXHAUSTION SYSTEM

Temperature of solution, ° F.	Screen-type film			Non-screen film		
	Period A, mins.	Period B, mins.	Period C, mins.	Period A, mins.	Period B, mins.	Period C, mins.
60	5½	6½	7½	8½	9½	11½
62	4¾	5½	6½	7½	8	9½
64	4	4½	5½	6½	7	8½
66	3½	4	4½	5¼	6	7
68	3	3½	4	5	5½	6
70	2½	3	3½	4½	5	5½
72	2½	2¾	3	3¾	4½	5
74	2	2½	2¾	3½	4	4½

The duration of each period is determined by the number of films processed and by the volume of the developer.

PERIOD A—covers the development of 11 films 14″ x 17″ or its equivalent—per gallon of solution.

PERIOD B—covers the processing of 12 films per gallon.

PERIOD C—covers the processing of 11 films per gallon.

At the completion of the cycle the solution should be discarded. Since adjustments of development time are based upon the area of film developed a record of the films processed must be kept on a pad, using symbols to denote the various sizes of film. In this way adjustments in time and final exhaustion of the developer can be determined without film wastage.

As the developer becomes exhausted the films show less complete blackening so that the completely exposed areas are grey, not black. These films are of inferior diagnostic quality and should be taken as an indication that the developer requires to be renewed.

Rinsing

After development, the film should be immersed in a rinse bath of clean, preferably circulating water or in an acid stop bath, for a period of at least 30 seconds.

This rinse has the effect of removing any excess developer from the emulsion and so stopping the reaction.

Rinsing also helps to prolong the life of the fixer.

Fixation

Clears the emulsion of all undeveloped silver halide grains and hardens the emulsion. Action of the fixer is influenced by its temperature and its freshness.

It is advisable that the fixer should be used at the same temperature as the developer—if possible 68° F.

The time required to dissolve away the undeveloped silver halide is the "clearing time," the time required to cause hardening of the emulsion is the "fixation time." The fixation time is usually approximately twice the clearing time.

Since non-screen film has very heavy emulsion layer it requires a much longer fixation period than does the screen-type film. It is advisable to time the fixation process and the necessary time will vary with the actual solution used; the type of film; the temperature and the amount of use to which the solution has been put.

Fixer solution	Times at 68° F.	
	Screen-type film	Non-screen film
Powder-type X-ray fixer (unreplenished)	5 minutes up to 16 minutes	10 minutes up to 20 minutes
Liquid X-ray fixer (unreplenished)	3 minutes up to 16 minutes	5 minutes up to 20 minutes
Replenished powder-type X-ray fixer	5 minutes up to 6 minutes	8 minutes up to 22 minutes
Replenished liquid X-ray fixer	3 minutes up to 4 minutes	

Improper fixation causes improper hardening of the film if too short a period is allowed, or loss of image density if an excessive period is used.

The usefulness of fixer solution ends when it loses its acidity or when the fixation requires an unduly long period.

If it is used further, abnormal swelling of emulsion and slow drying will result; with the risk of film staining also.

Washing

The finished radiograph should contain nothing but developed silver grains suspended in gelatin so that it is completely and fully inert to light or chemicals. This requires proper washing so that all the processing chemicals are removed. If washing is improperly carried out the image will discolour and fade, or the fixer will crystallise out in the film.

Washing is best done in running water, and if

possible the film hangers should be completely immersed.

Washing period should be 20 to 30 minutes for screen type film, and 30 to 40 minutes for the thicker non-screen film.

Drying

Drying of the films should be carried out in an atmosphere which is as dust-free as possible. Film should be dried in the hangers if these are the clip type, but if they are channel hangers they must be removed so as to allow the edges to dry. The films must *not* be allowed to stick together during drying.

Some Common Faults in Film Handling and Processing

As the final radiograph is subjected to careful scrutiny it is essential that it should make available as much information as possible. Various factors in the storage, handling and processing of the films may render the film less satisfactory from the diagnostic viewpoint by superimposing on the true image artefacts which could be mistaken for pathologic features.

It is important that the operator should be able to recognise these faults so that they can be discounted in the diagnosis and the appropriate steps can be taken to avoid their future occurrence.

The various faults will be discussed according to the stage at which they occur during film handling: —

Unsatisfactory conditions of storage

It can be claimed that from the moment film is manufactured it starts to accumulate "fog" but this can be minimised by satisfactory storage conditions. Storage for a long period of time should be avoided because of fogging which occurs due to cosmic radiation, a factor over which we have no control.

Improper stacking of film boxes (*e.g.* in form of pyramid, with the boxes placed horizontally and the largest at the foot) will cause fogging due to pressure on the films even in an unopened box. It will also cause fogging due to springing open of the box lid in partly used boxes.

Faulty box lid caused by improper stacking, or a damaged box lid, or opening a film box while the normal light is on, will cause fogging at one end of the film. (Fig. 18.) This is especially marked if the outer wrapping of the X-ray films is removed and the films are then returned to the box, with the open end of the folder proper facing towards the lid of the box.

Damp storage will cause a film with patchy fog and one which will have a poor image contrast.

Accidental exposure during storage. This is important while the film is in its box and also after the film is loaded into the cassette. Film close to the source of X-rays should be stored in a lead-lined box. A common source of trouble is the presumption that a brick wall is adequate protection. The film stock should be as far removed from the machine as possible.

This type of accidental exposure may cause the films to show a superimposed image and it may be possible to recognise the fault if a number of films show this feature.

Faults associated with mishandling of film

Pressure marks. These assume a number of different forms, the commonest being crimp marks caused by excessive bending of the film. These are usually crescent shaped and will show a reduced density if they have been caused before exposure, and an increased density if caused after exposure. (Fig. 19.) Another form of pressure mark seen commonly in veterinary work is caused by a dog drawing its claws across a packet of non-screen film prior to exposure. This results in a series of irregular white scores across the film. (Figs. 20 and 21.)

Static marks. Friction applied to the wrapping paper, the intensifying screens or the film surface itself, or rough withdrawal of the film from the wrapper, may cause the discharge of static electricity which will produce dark marks in different forms.

Faulty cassettes. Cassettes which have been dropped may be no longer light-proof and fogging tends to occur especially from one corner. Faulty cassette catches can also cause this defect, and improper closure of the cassette such as by closing a catch inside the cassette will cause localised fogging.

Scattered radiation fog commonly results from having the loaded cassette, unprotected, in the X-ray room, either before or after exposure. The backing material in the cassette may well be insufficient to afford protection.

Faults caused by intensifying screens

Dirt on screens. Any dirt on an intensifying screen will obstruct the fluorescent light and so produce a light spot or area on the film. (Fig. 22.) Common sources of this form of trouble include specks of dust, hairs, pieces of paper, cracks and scores on the screen surface and brown stains on the screens caused by developer splashes.

Safelight fog. Darkroom safelights are only safe if they are used according to the manufacturers' directions. Excessive time exposure to safelight will cause fogging, so too will close proximity to the safelight. Accentuation of safelight fog can be caused by laying the film on a sheet of white paper (or cassette clip) which reflects the light.

Faulty safelights will of course cause trouble: *e.g.* pin holes or cracks in the safelight may act much like a pinhole camera and produce an image of the safelight lamp on the film.

Finger marks. Contamination of the fingers with grease, or fixer, will cause marks of reduced density, while contamination with developer or copper will cause prints of increased density.

Developer splashes show up as darker spots on the film. Dry developer causes dark "dust-like" marks.

Fixer splashes on the dry film show up as clear spots, similar in a way to screen marks except for the shape, which is associated with a drop, also the image is cleared on one emulsion only. (Fig. 23.)

Development Faults

Improper time-temperature usage or the effects of

use of exhausted solutions will produce processing faults, but it is not intended to discuss these in detail in this paper.

Films fogged in tank. If the white light is switched on in the darkroom during development while the lid is off the development tank fogging, especially of the upper end of the film will result.

Reversal during development is caused if there is prolonged exposure to a faulty safelight or accidental exposure to white light after development has started. If this takes place the dark areas are light, and some light areas partly darkened. This change is explained by the protective action of the developed silver grains preventing any further action of the light on the silver halide in that area.

Insufficient solutions in tank results in a band of undeveloped film at one end, or a similar unfixed band.

Films in contact during development result in a partial development of the film, usually with an undeveloped area on one side.

Improper mixing of developer. This causes uneven development of the film. This is particularly important where only occasional use is made of a developer tank and if it is heated specially for each occasion by an immersion heater. If the solution is not thoroughly mixed it will be so much warmer at the top of the tank and as a result the top of the film will be much more developed than the lower end.

Reticulation occurs if a film is rinsed in hot water after development at 68° F. This sudden change in temperature sets up strains in the gelatin with reticulation.

Fixation Faults

These include use of exhausted fixer which gives rise to yellow stains on the film, or in some cases although the film appears to be cleared it may have formed an insoluble compound which does not wash off but decomposes slowly producing gradually increasing yellow stains. If 2 films are in contact during fixation similar staining may develop, but in this case the stain is localised.

Faults during washing

Insufficient washing may result in fixer crystallising on the film leaving a white, slightly sticky deposit.

These fixing salts deposits will decompose slowly and cause film staining.

Excessive washing, especially in warm weather, causes the emulsion to swell excessively because the washing water, unlike the processing solutions, does not contain various dissolved salts which tend to prevent excessive gelatin swelling. This excessive emulsion swelling renders the film very liable to damage and in hot weather spots of emulsion may melt sufficiently to become detached from the base, leaving clear patches which show a slight surface depression.

If the washing water is not changed sufficiently frequently or if the tank is not cleaned, it may become contaminated by bacteria which attack the gelatin, leaving white spots with dark edges.

Drying marks

If a partly dried film is splashed with water, or if a drop of water from the hanger runs down the film, the gelatin of the area of the film affected swells again and the surface tension draws the silver in the image away from the centre, towards the edge of the swollen area. This produces an area or streak of reduced density, with a darker border.

These marks can be avoided if the film is totally immersed in water immediately. Once the mark is established it cannot be removed.

Melting of emulsion

This occurs most readily while the film is still wet and is caused by prolonged exposure of the soft film to the heat of an illuminator. Fluorescent illuminators do not tend to cause this effect because of their low heat production.

Protection

At the present time in world history with so much awareness of the biologic effects of excessive exposure to ionising radiation it might be presumed that very little need be said on this subject. Unfortunately this is not true, since every veterinary surgeon who operates an X-ray machine is in much greater danger from this harmless looking piece of equipment than he is from atom bombs.

Radiation hazards have been recognised for many years and have been the subject of deliberations of national and international organisations since about 1920. These committees have issued many recommendations dealing with all aspects of the subject. One particularly important concept which became generally accepted about 1930 was that of a "tolerance dose," an idea which was useful, but in some ways regrettable. There is no reliable evidence for any true threshold effect in radiation injury and it must be presumed that all radiation is harmful. The so-called "tolerance dose" should be regarded merely as a useful index in the appraisal of a radiation safety programme. The value of this "tolerance dose" has altered very markedly since 1902 when Rollins in Boston claimed that "if a photographic plate is not fogged in 7 minutes, the radiation is not of harmful intensity." This would represent a dose of 10 to 20 rontgen (r) units per day —approximately one thousand times the value now accepted as the limit of safety. Many estimates of the "tolerance dose" have been made over the years, but all that can be claimed is that if there is a "tolerance dose" it lies between 0.0003 r/day (the background radiation from cosmic days, etc.) and 1 r/day (the level at which chronic irradiation is known to produce unmistakable systemic effects). All modern authorities agree that present knowledge does not support the belief that there is a tolerance level for radiation.

The undoubted benefits must be weighed against the risks to the individual and the population as a whole. While the present uncertainty continues, *everyone who employs radiation should do so as sparingly as possible.*

Veterinary surgeons who use X-rays as a diagnostic method should bear in mind the following facts: —

(1) The *effects of irradiation are cumulative,* and they must be considered as being effective throughout the individual's entire life.

(2) Direct exposure to the primary beam should be avoided by the operator *at all times,* no matter what temptation may be offered. (The damaging effects of primary beam are very much more than the scatter which is present throughout the X-ray room.)

(3) The coverage of the primary beam should be restricted to the actual requirement, by the use of cones. This results in better films, less scatter and less risk of primary irradiation.

(4) The use of fluoroscopy should be kept to an absolute minimum and should never be undertaken without

(a) proper protective clothing—including lead-rubber gloves and apron;

(b) properly protected fluorescent screen, *i.e.* one with a lead glass backing. (N.B. The type of lightweight hand screen with a hood to assist in excluding light is extremely dangerous.)

(5) The operator should be as far as possible from the source of X-rays. This uses the effect of distance and causes a very substantial drop in the intensity of the X-rays, also of scatter.

(6) The operator should whenever possible be positioned behind an X-ray opaque screen.

This has the effect that he is not subjected even to secondary scatter, as happens if he is merely stationed outside the primary beam, but is now subjected only by a back scatter *i.e.* secondary rays which have been reflected from the walls of the X-ray room.

If no such screen is available, protective lead-rubber aprons and gloves should be worn at all times.

(7) Members of staff, who are subjected repeatedly to minor doses of radiation, should *not* hold animals for radiography because of markedly increased risk of excessive dose.

The animals should be restrained by their owners, despite the fact that this will often require lengthy explanations as to the exact requirement for positioning.

Such persons should at all times be provided with protective clothing and positioned so as to avoid the useful beam.

It is often better to avoid the use of lead-rubber gloves, and to cover the owner's hands by a sheet of lead, curved to a suitable shape.

(8) If trial exposures must be made to assess the setting of the machine steps should be taken to absorb the X-rays produced—*e.g.* have the aperture of the cone of the X-ray tube covered by a thick sheet of lead.

(9) If the thickness of the patient and output of the machine require a very prolonged exposure it is much more satisfactory, *and much safer,* if the animal is anaesthetised for radiography since this will permit of a useful film being obtained on the first exposure and reduces the effects of irradiation both on patient and operator. The necessity for manual restraint is also eliminated.

(10) If a moderate amount of X-ray work is carried out the assistance of an organisation which carries out a radiation monitoring service may be obtained. These bodies will assess the amount of irradiation being received, by the use of film badges. Anyone using this service must subscribe to the conditions laid down, which include continual supervision, and the acceptance of the suspension from work involving radiation, for a prescribed period if excessive doses are recorded.

Conclusion

The increasing use by members of the veterinary profession of radiographic techniques is a major step forward in clinical work, but it brings with it many difficulties and responsibilities as well as great convenience and help in arriving at clinical diagnoses.

This paper has been designed to help the veterinary surgeon who has purchased an X-ray machine, but has not received formal instruction in its use, to overcome the many difficulties which are encountered in radiographic work. With this object in mind the subject has been split up rather arbitrarily into relatively small sections which stand more or less on their own and can be read separately.

X-ray protection has been left to the last section, but this is not because it is the least important, rather the reverse, and it is hoped that this paper will stimulate a feeling of responsibility on the part of veterinary surgeons using X-ray equipment towards both their staffs and to themselves.

The author wishes to apologise for the rather pedestrian presentation of this material, none of which is new, but he hopes that by virtue of its being collected together in this form it will be of some value.

Acknowledgments.—The author would like to thank the many people who have assisted in the completion of this paper, both by constructive criticism and by preparation of illustrations. These include: —P. N. Leahy, B.V.M.S., M.R.C.V.S., J. Nicoll, M.S.R., A. Finnie, and Messrs. Kodak and Ilford for permission to use many of their illustrations.

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The Speaker's Introduction

The Chairman, Mr. T. Denholm, said that the end of a very memorable week was approaching, and although it would be unfair to suggest that the best wine had been kept to the end, nevertheless, the afternoon's paper was one of the most important of the Congress.

Mr. D. D. Lawson, the author, would be no stranger to his audience; he had been seen in glorious Technicolor on at least 3 occasions during the week. He was a graduate of the Glasgow School, and radiography was one of his special subjects. Those who were at Folkestone, would remember seeing the very excellent X-ray plates shown by Mr. Lawson on that occasion. He then called on Mr. Lawson to give his paper.

Mr. Lawson thanked the Provisional Committee for asking him to present his paper on radiography. He had had misgivings about the value of a paper on that subject but from the interest which had been shown, and from the enquiries which he had received from practitioners regarding radiographic technique, it had evidently been his mistake and not that of the Provisional Committee. A further feature which had recently come to hand was that a publication was in the process of preparation by staff of the Bristol School on the subject of radiography for veterinary practice, and this also indicated that people other than the Provisional Committee were of the opinion that publications on the subject of radiography were in demand.

The title of the paper as presented was not intended to exclude those who were interested in large-animal radiography; it was used purely to indicate that there was no intention of elaboration on the many special problems which are presented in dealing with the larger domestic animals.

He did not intend to cover the whole scope of the paper but only a few selected points which were most important in relation to successful radiography.

In order to be successful in radiography it is essential that the operator should understand something of an X-ray tube and this operation was discussed in relation to the electron cloud; the difference of potential across the tube; the production of heat and X-rays and the fact that heat produced in the X-ray tube is the main factor limiting actual output of the tube. The subject of rectification was discussed briefly and it was shown that the electron stream in a non-rectified or self-rectified machine can only pass across the tube when the anode is positive in respect of the cathode—that is, for only one-half of each cycle of alternating current. In large machines valves can be introduced so that on both halves of the cycle the current can be made to pass across from the cathode to the anode of the tube, these being kept at a constant relationship to one another during both half cycles; this is known as full wave rectification.

The factors which control X-ray production therefore are tube current measured in milliamperes multiplied by time and the difference of potential (e.m.f.) across the tube that is the kilovolt setting. To assess the effects of each of these on the X-ray plate it is necessary to use a standard object which can be radiographed, and Figs. 9 and 10 in the paper are radiographs made of an aluminium step wedge which is composed of a series of sheets of aluminium, laid one on top of the other, so as to give a standard increase in thickness of the aluminium of the step wedge at each succeeding step. This device is a stationary object of standard X-ray opacity and with sharp edges at each change in thickness and is useful in showing up the effects of different types of machine setting. In Fig. 9 the exposure only has been increased, that is the settings of the machine have been changed only in relation to the milliamp seconds setting. This plate shows the effect of increasing exposure so that progressively more of the plate shows blackening as the exposure is increased. In other words an increase in film density has occurred with increasing exposure but there is no alteration in the contrast of the various steps in relation to each other. The effect has merely been that of a shift of position of the end of the visible steps on the X-ray plate. Fig. 10 has been taken showing the effects of alteration in the kilovolt setting of the machine. All the exposures were made at a constant milliamp seconds setting and for each succeeding exposure the kilovolt peak of the machine was increased. It is noticeable that as the kilovolt is increased so the density of the plate is affected because of increased penetration and much more important the relative contrast between the adjacent steps of the wedge show alteration and diminution in contrast as the kilovolt value is increased.

The subject of detailed visibility was discussed in relation to various factors such as the geometry of X-ray image formation and the effect of scatter on detailed visibility and the effects of screen grain size on the final X-ray produced. The value of the Heel effect of a tube that is the cut off of the beam which occurs naturally because of the angle at which the anode is set relative to a vertical plane was discussed and it was pointed out that the intensity of the X-ray beam varies considerably from the central ray to the anode end and to the cathode end of the beam and this effect could be used in making more even exposures of structures of varying thickness.

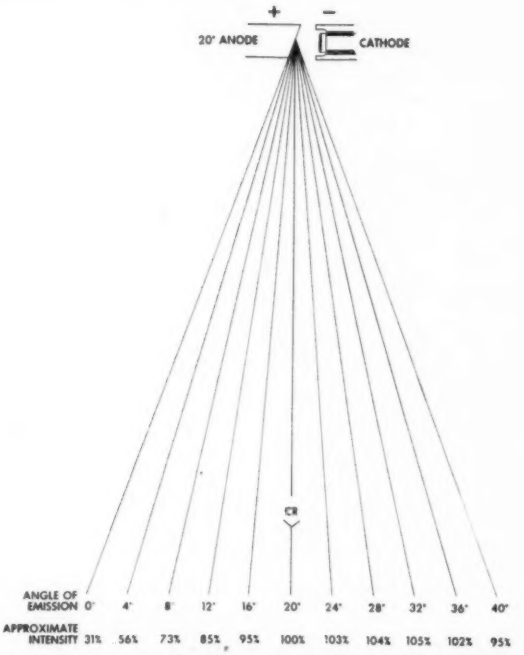

Diagram of the "Heel Effect" of the cut off of the X-Ray Beam which is caused by the angle of the Anode face. CR = central ray.

The relative merits of radiographic procedures and fluoroscopic procedures were discussed and the difficulties of protection while using fluoroscopy were stressed. The attention of the members was drawn to the importance of X-ray protection which was a subject of fine importance to all who were employed in radiographic work. The X-ray machine is for those people a very important source of ionising radiation.

The Opener

The Chairman thanked Mr. Lawson, who had explained the very technical points in a most lucid manner.

Members of the Provisional Committee considered themselves very fortunate that Mr. K. P. Anderson of Stirling had consented to open the discussion on Mr. Lawson's paper. Mr. Anderson would be known to many as President of the Scottish Branch. He practised in Stirling, was a member of the Council and a good friend to many.

Mr. K. P. Anderson, opening the discussion, said that

radiography had become virtually an essential part of the service given by any practice, where small-animal diagnosis and treatment was undertaken. In fact, one might endorse the statement made by Schenelle in America that failure to use radiography where its use was essential to establish a true diagnosis could constitute at that time a basis for a charge of malpractice.

It was therefore with very great pleasure that he congratulated the Organising Committee on providing the subject at the Congress, and for having the good sense to ask Mr. Lawson to be the author of the paper.

Mr. Lawson was nothing if not thorough and had covered the ground of radiographic technique in such a complete manner that he had made the task of the opener of the discussion an unenviable one. Mr. Anderson spoke as a practitioner who had used X-rays as an aid to diagnosis in the small-animal side of his practice for about 20 years, but could lay no claim to being an expert.

The physics of X-ray production were not always fully understood by those who in practice were using X-rays, it being so much easier merely to familiarise oneself with the relatively simple data, given with the manual of instruction for the machine purchase.

It was therefore pleasing to see in the paper the relevant facts, gathered together in an easily understandable form, which would lead many people to a better understanding of the principles underlying radiography.

One of the greatest difficulties faced on commencing the use of X-rays was the proper calculation of the factors necessary to ensure correct exposure: the M.A.S. kilovoltage, type of film, FF distance, and whether or not a screen was used. The table in the paper gave a very clear guide for the various settings required, and corresponded very closely with those he had arrived at by trial and error over the years.

What was Mr. Lawson's opinion of the method of exposure of calculation as published recently by Banks in America, where the M.A.S., FF distance and time were kept constant, the only variable being the kilovoltage which was increased or decreased 2 kilovolts peak for each increase or decrease of 1 cm. in the thickness of the part to be radiographed?

Banks also recommended that, where a grid was used, the M.A.S. should be increased by a factor of 5. That seemed to him to be rather high, being accustomed to increase M.A.S. by a factor of 2, where a stationary grid was used. Would Mr. Lawson say what increase in M.A.S. he calculated was necessary when he employed a grid?

While he appreciated that it was not possible in one paper to cover all the aspects of radiography, he would have liked Mr. Lawson to have enlarged the section on positioning, which he felt contributed as much as any other single factor to the production of an X-ray which would be of good diagnostic value.

What method of positioning did Mr. Lawson adopt for obtaining a good A.P. plate of an elbow joint? That was something he had always found difficult if a foreshortened view of the distal end of the humerus was to be avoided.

Did Mr. Lawson employ anaesthesia or sedation in animals which were difficult to position? His own practice was to use light thiopentone anaesthesia or chlorpromazine sedation in any animal when proper position was going to cause discomfort, and so prevent the stillness which was essential.

Did Mr. Lawson use a compression band when taking a radiograph of the chest, or did he use any other method of temporarily inhibiting the breathing?

The use of contrast media was increasing greatly in small-animal radiography, for example, in delineating non-radio opaque foreign bodies in the alimentary canal, by means of barium suspension; in outlining the bladder with sodium iodide solution, in tracing the depth of a discharging sinus with one of the compound organic iodides, or in outlining the kidney pelvis, and the ureter, by means of intravenous contrast media.

At what intervals would Mr. Lawson take plates following the oral administration of a barium suspension, to be sure that sufficient time had elapsed to have allowed the barium to have traversed the small intestine? While it was realised that many factors might influence the time required, it would be helpful to have his opinion of the time he considered most suitable.

What was Mr. Lawson's opinion of the method of producing artificial pneumoperitoneum, either with air or oxygen, as an aid in delineating the visceral organs, in particular the uterus? That was a technique he himself had always fought shy of as it seemed to him that it could not be devoid of danger.

Mr. Lawson rightly stressed the necessity of having correct processing to obtain useful radiographics. One of the difficulties in practice was to obtain that without the necessity of incurring heavy capital expenditure in the purchase of thermostatically controlled developing and fixing tanks. He himself had found very satisfactory a lead-lined wooden box, large enough to hold 3 two-gallon tanks, one for developer, one for rinsing, and one for fixing. The box was filled with water, and into it was led the heating element and thermostat of a "Cambridge Regulator," which would maintain the water in the box, and the solutions in the tank, at any desired temperature, between 60° and 70°F, with the minimum consumption of current. That method was preferable to using a portable immersion heater, with which it was so easy to overheat and ruin the developer.

He was glad to see that Mr. Lawson had made a particular point of stressing the necessity for protection against X-rays as this was frequently neglected.

X-rays were dangerous, but because of the slow and insidious nature of their effects, perhaps long after exposure, that fact was possibly not appreciated as it would be if the effects were immediate.

While it was difficult for the effects of X-ray scatter to be entirely avoided, direct radiation from the machines could and must be avoided, and it was a duty to see that staffs were adequately protected.

Lead rubber gloves were most difficult to use, when handling animals, and recently he had found it much easier to cover the hands of those restraining the animal with a small sheet of lead. In addition to that, it was very useful to have the animal sedated so that those in attendance could stand very much further back and control it by tapes put on the legs, so that they were not in the direct beam of the X-ray.

He concluded by thanking Mr. Lawson for his very interesting and informative paper.

The Reply

Mr. Lawson, in reply, congratulated Mr. Anderson on his opening of the discussion; it had been most ably done. He understood that his was a most difficult paper to open discussion on because there was relatively little of a controversial nature in it.

The first question asked by Mr. Anderson was on the Banks technique of maintaining constant M.A.S., FF distance, and using only kilovolt variation. That technique had been used in this country as well as in America for many years, but it was only with a relatively large machine that the method was possible.

Most veterinary practitioners, however, used only small, portable machines which have only a very small variation in the kilovolt range; often only 3 stops. When these machines are being employed much more ingenuity is required on the part of the operator to obtain good radiographs.

With regard to Banks's recommendation that, where a grid was used, the M.A.S. should be increased by a factor of 5, Mr. Lawson pointed out that that was not a simple factor and should not be read in the context in which Mr. Anderson had read it. Most of the grids built into hospital X-ray tables had a 5 times factor, but the smaller stationary grids often had a factor of as low as 1.2 or 2, and this depended on the ratio of the total thickness of the grid slats from back to front, compared with the space between the grid slats. That factor was merely an attempt to compensate for the amount of X-rays which were extracted from the original beam by the presence of the grid. In other words, it was purely a method of maintaining the density of the film.

The elbow was always difficult. A method he had found most successful was to angle the actual tube, taking the exposure at 20°, and to place the X-ray plate behind the animal's extended forearm, with the forearm flat on the table and the plate placed so that the lower edge of the plate was somewhere about the middle of the forearm, and the plate lay behind the humerus. In that way, there was not too much foreshortening of the humerus; there was always some. It was unwise to attempt to obtain a total exposure of the whole humerus from elbow to shoulder in that way; the elbow joint could be taken reasonably satisfactory.

Anaesthesia and sedation: that was a thorny problem. Everyone in practice knew that there were many animals that would be better anaesthetised before X-ray, and every owner resisted it. His experience in Glasgow was very limited, with the use of chlorpromazine as a tranquilliser. That was limited to a few cases where dogs were inclined to bite and when it was given to them, they no longer looked as though they were going to bite: they just simply bit!

With regard to radiography of the chest, he was not in the habit of using compression bands on the chest. One point which had not been mentioned was that on occasions it was very valuable to obtain a lateral projection of a dog's chest with the dog in the standing position. This was particularly true in cases where there was a hydrothorax, where, with the dog in the standing position, the degree of it would be revealed. Where the dog was lying in lateral recumbency, the X-ray would reveal that there was X-ray opaque material.

On respiration, he said that if animals were anaesthetised for chest X-ray, and it was necessary to inhibit respiration for a specific reason, that could be done by using an endotracheal tube and compression of the rebreathing bag.

With regard to the interval between the administration of a barium suspension and taking plates, Mr. Anderson had picked on something he could not answer. As far as emptying of the stomach was concerned, the time was somewhere between 15 and 20 minutes. That was quite a liberal time for the emptying of a stomach which was not a food-filled stomach but contained only barium. For the time of emptying the small intestine, he could not answer.

Mr. Lawson described the method of producing artificial pneumoperitoneum, which was a relatively new method and required a great deal of development, and much attention paid to the interpretation of the findings obtained.

Processing was very important and that had been stressed in the paper to a considerable extent. He was interested to hear Mr. Anderson's description of a wooden box with a thermostat and water. This was, in fact, Mr. Anderson's home-made version of the commercially-available thermostatically controlled tanks and was the same thing in essence. That was the easiest way at present of obtaining satisfactory results with processing because it maintained standard temperature in all the solutions. There were hopes that some time in the relatively near future some of the photographic manufacturers working on chemicals might produce a solution which was equivalent to the one now being developed for ordinary photographic work in which there was a developer fixer solution. Not the least of the interesting characteristics of that was that it was effective over a wide range of temperature, which would result in great saving to the veterinary surgeons. Unfortunately, for X-ray work, this was not satisfactory at present but in the future would probably become so.

With regard to adequate protection, all he could do was to underline Mr. Anderson's statements to the absolute maximum of his ability. X-rays were, in fact, exceedingly dangerous.

Although the statement in the paper that "veterinary surgeons operating X-ray machines were in much greater danger from these machines than they were from atom bombs" might appear a little flippant, it was nevertheless true. It was possible for anyone to cause himself extensive damage at any time with an X-ray machine which proceeded to produce ionising radiations in its own quiet and unnoticed way and it is the responsibilty of all persons using such machines to be fully aware of the dangers involved.

One small point of slight difference. Mr. Anderson said he used small lead sheets for covering the hands. He himself would recommend the use of large lead sheets which were pliable, or moderately so, and not too expensive. He would prefer, if the animal was anaesthetised, to string it out in the required position and go out of the room altogether and have only the person operating the machine behind the X-ray protective screen. In large-animal work, one of the things which had not been developed in this country and which should be developed were holders to hold the film so that the people doing the manipulation could keep right out of the way.

The General Discussion

The Chairman asked how much air Mr. Lawson would inject into the abdomen.

Mr. Lawson replied that the volume was purely arbitrary. The figure was arrived at by tapping on the animal's abdomen and getting it to a nice rotundity. One started with a skinny dog and ended up with a nice fat one.

Dr. R. N. Smith (Bristol) showed slides of X-ray damage to hands. Some of these were shown by courtesy of the American Animals Hospital Association. He then stressed that the use of students to hold animals was to be condemned and pointed out that he always anaesthetised all small animals that he X-rayed. If an animal was fit enough to be X-rayed, it was fit enough to be anaesthetised. He only used pentobarbitone anaesthesia, but that was good enough.

Mr. Lawson, in reply, said that one point about Dr. Smith's statement did not ring true for clinicians. He had said that if an animal was fit enough to be X-rayed it was fit enough for an anaesthetic. If an animal was unfit enough to be X-rayed, anaesthesia was a serious risk. It was a big point in animal radiography. He was sorry to disagree, but that was his viewpoint.

He underlined everything that Dr. Smith had said in relation to the hazards of X-ray damage and he also had personal knowledge of several veterinarians who had exposed themselves to excessive radiation; in one case the person involved had been warned that he must not be exposed to X-ray radiation for the rest of his life.

Despite all the danger and difficulty, radiography was an extremely valuable adjunct to veterinary clinical work. It required still a vast amount of exploration and development.

The Chairman proposed a very hearty vote of thanks first of all to Mr. Anderson, for starting the ball rolling in so excellent a way; and to Mr. Lawson who had given everyone a great deal to think about, not all of it too dreadful! Some who had been using X-rays for a good number of years in general practice still hoped to go on for a little while longer!

THE ROYAL COLLEGE OF VETERINARY SURGEONS

Temporary Building

The present office of the College at Red Lion Square will be closed at 5 p.m. on the evening of Thursday, December 29th, and will re-open at the new temporary address—College House, Wright's Lane, Kensington, W.8.—on Monday, January 2nd, 1961, at 9.30 a.m.

It is asked that enquiries and correspondence may be kept to the minimum during the week immediately before and after the move.

Wright's Lane runs south from Kensington High Street along the side of Messrs. Pontings. College House is a modern office block on the left towards the bottom of Wright's Lane, when approaching from Kensington High Street. The College accommodation will be on the first floor. Kensington High Street Station (District and Circle lines) is immediately adjacent to the temporary College building.

Investigations on Berenil Resistance of Trypanosomes

BY

R. FUSSGÄNGER and F. BAUER

Pharmaceutical Division of the Farbwerke Hoechst AG., Frankfurt a.Main

SUMMARY.—It has previously been shown that Berenil, 4: 4' - diamidino - diazoaminobenzene - diaceturate, displays a rapid action on trypanosomes both in vitro *and* in vivo *(Bauer, 1958 ; Hawking, 1958 ; and others). Following the injection of this drug relatively high blood concentrations are produced, which are, however, of short duration only. For that reason Berenil is primarily a curative drug, and not a prophylactic agent.*

Experiments are reported concerning the development of Berenil-resistant Trypanosomes.

Over a period of 44 weeks no indication of development of resistance occurred in a Tryp. congolense *strain subjected to 20 passages through Berenil-treated mice. One* Tryp. congolense *strain which, due to the administration of another diamidine, had become resistant in cattle to 5 times the usual curative dose of Berenil did not retain this resistance when further passaged through Berenil-treated mice : the resistance was lost again completely after 13 passages within a period of 36 weeks. These results appear to support the supposition that Berenil will not promote the development of resistant* Trypanosoma *strains even if subtherapeutic doses are administered continuously. This indicates that the various diamidines should not be considered as equal with regard to the induction of resistance of trypanosomes.*

Introduction

STARTING from a quinaldine derivative, Congasin, which has an established activity against *Trypanosoma congolense*, Jensch (1955) and Fussgänger (1955) were able to develop Berenil*, a drug with excellent activity against infections caused both by trypanosomes and babesiae. A large number of publications deals with the experimental and clinical application of this drug (Bauer, 1955, 1956, 1958 ; Chavarria *et al.*, 1958 ; Enigk & Reusse, 1955 ; Fussgänger, 1955 ; Fussgänger & Bauer, 1958 ; Hawking, 1958 ; Milne *et al.*, 1955 ; Nash, 1957 ; Puccini *et al.*, 1958 ; Ranali *et al.*, 1958 ; Simic *et al.*, 1956 ; Tonking *et al.*, 1956 ; and others). These publications indicate that Berenil constitutes an outstanding therapeutic agent against infections due to *Tryp. congolense* and *Tryp. vivax*, which it eliminates completely and in a sterilising manner. Berenil also appears to be the drug of choice for the treatment of infections caused by *Babesia bovis*, *B. bigemina*, *B. argentina*, *B. ovis*, *B. motasi*, *B. trautmanni*, *B. perroncitoi*, *B. canis*, and *Nuttallia equi*.

*Farbwerke Hoechst A.G.

Chemically, Berenil is 4 : 4'-diamidino-diazoaminobenzene-diaceturate (according to the Geneva nomenclature : di-(-4-amidinophenyl)-triazene-(N-1 : 3)-diaceturate (Fig. 1).

The studies of Fussgänger & Bauer (1958) and Dibbern (1958) on the distribution and excretion of Berenil in dogs indicate that this drug is detoxicated and excreted within 24 hours of intramuscular administration. Consequently it may be concluded that the preparation displays a very rapid action on blood parasites.

Bauer (1958), conducting *in vitro* experiments, demonstrated that *Tryp. congolense* is killed by Berenil at a concentration of 2 mcg. per ml. within a period of 6 hours, and with a period of 4 hours at a concentration of 4 mcg. per ml. He further showed that *in vivo* the substance is irreversibly bound to the trypanosomes within a relatively short time although several more hours will elapse before the organisms are killed. In infected bovine animals and dogs treated with singular intramuscular injections of 3·5 mg. Berenil per kg., the blood in no case remained infective 5 hours after treatment. Berenil exerts a direct effect upon trypanosomes, and blocks the sugar metabolism of the parasites in a similar way to other preparations used against trypanosomes. Hawking (1958) found that Berenil, at a concentration of 0·5 mcg. per ml. killed trypanosomes within 20 hours, and he observed that the plasma of rabbits has a trypanocidal effect 6 hours following a Berenil injection. After 24 hours, however, this effect is no longer apparent.

The results of these investigations indicate that Berenil represents primarily a curative drug and that a very long prophylactic effect cannot be expected. This fact was confirmed by means of experimental studies with *Tryp. congolense* in which a dose of 3·5 mg. Berenil per kg. intramuscularly afforded prophylactic protection in cattle only for a period of 2 days and in sheep for only 3 to 4 days (Bauer, 1958).

On the one hand a more protracted prophylactic activity appears desirable for anti-*Trypanosoma* preparations. On the other hand the hazard of the development of resistant *Trypanosoma* strains is the greater, the longer a preparation is circulating in the organism treated, and the more slowly it displays its

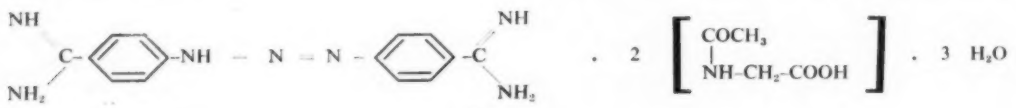

FIG. 1.

activity. The rapid action of Berenil and its brief persistence in the blood reduce this hazard by a marked degree. Chemically, Berenil is a diamidine, and therefore related to stilbamidine and pentamidine. There are, however, considerable differences between these preparations as far as their range of activity is concerned (Hawking, 1958). There also exist differences between individual diamidines with regard to the development of resistant *Trypanosoma* strains.

Generally, there is a resistance of *Trypanosoma* strains to the various diamidines, which on the basis of the investigations of Hawking (1958) may be called cross-resistance. Thus, Fulton and Grant (1955) succeeded in making a strain of *Tryp. rhodesiense* resistant to the maximum dose of stilbamidine by continuous administration during 61 passages through the mouse. Furthermore, Kaltenbach (1959), who performed a total of 28 passages through the mouse, achieved a partial resistance to *Tryp. equiperdum* during administration of stilbamidine.

Experimental Studies

In our experiments we first attempted to make resistant a strain of *Tryp. congolense* by consecutive passages through mice during Berenil administration. For this purpose groups of 3 mice were treated subcutaneously with single doses of Berenil of 0·06 mg., 0·08 mg., 0·10 mg., 0·12 mg., 0·14 mg., 0·16 mg., 0·18 mg., and 0·20 mg. per 20 g. mouse respectively. Berenil was given after an intraperitoneal infection with trypanosomes had become manifest by appearance of parasites in peripheral blood. Subsequently the blood of these mice was subjected to daily microscopical examinations over a period of 21 days. A new series of mice was then infected with the blood of the mouse receiving the highest dose of Berenil which just permitted a recurrence of infection. (In 3 cases blood was used from a mouse of the second highest dosage group showing recurrences, because a mouse of the highest group relapsed much later.) Table I shows that in the course of 20 passages through the mouse during treatment with Berenil no resistance occurred in our *congolense* strain over a period of 44 weeks, and the sensitivity of this strain shows minor variations only.

In the course of investigations with other anti-*Trypanosome* compounds, we re-isolated the same *congolense* strain from the blood of a bovine animal after repeated relapses and despite 3 administrations of increasing doses of our compound No. 12110. This substance is di-amidino-hydrazone which contains only one benzene ring. We inoculated this R-strain into mice and tested its sensitivity to Berenil. A dose of 0·65 mg. of Berenil per 20 g. mouse was necessary to cure mice infected with this strain, compared to 0·12 –0·18 mg. per 20 g. with the initial strain. Thus after 3 administrations of di-amidino-hydrazone No. 12110 to the bovine, the *congolense* strain had become 4 to 5 times more resistant to Berenil.

This R-strain with its indirectly-induced partial resistance to Berenil was now used in consecutive passage through mice treated with Berenil to find out whether resistance would increase, decrease or be maintained.

As before, groups of 3 mice each were treated subcutaneously with Berenil after intraperitoneal in-

TABLE I

BERENIL DOSAGE IN MG PER 20 G. S.C.

Passages through the mouse	0·06	0·08	0·10	0·12	0·14	0·16	0·18	0·20
Passage No.								
1	+	+	+	Neg.	Neg.	Neg.	Neg.	Neg.
2	+	+	+	+	"	"	"	"
3	+	+	+	+	+	+	"	"
4	+	+	+	Neg.	Neg.	Neg.	"	"
5	+	+	+	"	"	"	"	"
6	+	+	+	"	"	"	"	"
7	+	+	+	+	+	+	"	"
8	+	+	+	+	+	+	"	"
9	+	+	+	+	Neg.	Neg.	"	"
10	+	+	+	+	+	"	"	"
11	+	+	Neg.	Neg.	Neg.	"	"	"
12	+	+	"	"	"	"	"	"
13	+	+	+	+	+	"	"	"
14	+	+	+	Neg.	Neg.	"	"	"
15	+	+	+	+	+	"	"	"
16	+	+	+	Neg.	Neg.	"	"	"
17	+	+	+	"	"	"	"	"
18	+	+	Neg.	"	"	"	"	"
19	+	+	+	+	"	"	"	"
20	+	+	Neg.	Neg.	"	"	"	"

Sensitivity of a strain of *T. congolense* in 20 passages during treatment with Berenil.

\+ = At least one out of 3 mice is positive in the group concerned.

Neg. = Each of the 3 mice of one group is negative during an observation period covering 21 days.

↓ = Inoculation and infection, respectively, of each of a new group of mice for the next passage.

TABLE II

BERENIL DOSAGE IN MG. PER 20 G. S.C.

Passages through the mouse	0·2	0·25	0·30	0·35	0·40	0·45	0·50	0·55	0·60	0·65
Passage No.										
1	+	+	+	+	+	+	+	+	+	Neg.
2	+	+	+	+	+	+	+	+	Neg.	„
3	+	+	+	+	+	+	+	+	„	„
4	+	+	+	+	+	+	+	+	+	„
5	+	+	+	+	+	Neg.	Neg.	Neg.	Neg.	„
6	+	+	+	+	Neg.	„	„	„	„	„
7	+	+	+	Neg.	„	„	„	„	„	„
8	+	+	Neg.	„	„	„	„	„	„	„
9	+	+	„	„	„	„	„	„	„	„
10	+	Neg.	„	„	„	„	„	„	„	„
11	+	+	„	„	„	„	„	„	„	„
12	+	Neg.	„	„	„	„	„	„	„	„
13	Neg.	„	„	„	„	„	„	„	„	„

Decrease of resistance of a *T. congolense* strain originally resistant to Berenil during Berenil administration in 13 passages.

\+ = At least one out of 3 mice is positive in the group concerned.

Neg. = Each of the 3 mice of one group is negative during the observation period covering 21 days.

↓ = Inoculation and Infection, respectively, of a new series of mice for the next passage.

fection with trypanosomes had become manifest. The following doses were used this time : 0·2 mg., 0·25 mg., 0·3 mg., 0·35 mg., 0·4 mg., 0·45 mg., 0·5 mg., 0·55 mg., 0·6 mg., 0·65 mg. Berenil per 20 g. mouse. The blood of these mice was examined for the presence of trypanosomes for 21 days. Each fresh passage into mice was carried out as described above, with the blood of the mouse showing a recurrence after the highest Berenil dose—in 3 cases starting from a mouse of the "second highest" group.

Table II shows the result of this experiment. The resistance to Berenil produced indirectly in our *congolense* strain by a di-amidino-hydrazone did not persist in the subsequent passages through the mouse during continuous administration of Berenil, nor did it show any increase ; instead a continuous decrease was seen, so that the original sensitivity of the initial strain was restored after 13 passages during a total period of 36 weeks.

Discussion

The development of resistant *Trypanosoma* strains is of great importance in view of the application of drugs in Africa. The *Annual Report* 1957 of the Department of Veterinary Services of Kenya states that strains of *Tryp. congolense*, *T. vivax*, and *Tryp. brucei*, which were partially resistant to 2 mg. prothidium* per kg., revealed a cross-resistance to antrycide† 5 mg. per kg. and ethidium* 2 mg. per kg., but were sensitive to Berenil when the substance was given in the dose of 5 mg. per kg. A *congolense* strain with " hyper "-prothidium resistance developed in the laboratory proved resistant to all of the known anti-*Trypanosoma* preparations—including Berenil.

Hawking (1958) found in his experimental studies on mice that a strain of *Tryp. equiperdum* resistant to antrycide was highly sensitive to Berenil, but that a strain of *Tryp. rhodesiense* resistant to stilbamidine revealed full resistance also to Berenil.

These experiments indicate that a resistance to Berenil exhibited by *Trypanosoma* strains may exist but only under special conditions. (In our own experiments we were likewise able to produce Berenil

*Boots Pure Drug Co. Ltd.

†Imperial Chemicals (Pharmaceuticals) Ltd.

(*Concluded at foot of page opposite*)

An Apparatus for Inhalation Anaesthesia in Large Animals

BY

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INHALATION anaesthesia involves the application of some method by which gaseous and volatile anaesthetic agents are absorbed from the lungs into the blood and are transported round the body in the circulation. These agents are carried into the lungs by a vehicle, which may be air or oxygen or a mixture of both, and there are several recognised methods by which this may be brought about:—

1. *Open method.* Here, a mask is used, which covers the nostrils and usually the mouth as well, but in order to prevent asphyxiation, entry of air or oxygen and escape of exhaled gas is allowed to occur between the mask and the face, or through special "air-holes." The anaesthetic agent is either blown into the mask along with its vehicle, or it is placed inside the mask on an absorbent pad. This method has been practised in large animals for many years, several mask inhalers having been developed for the purpose.

Such methods require little apparatus and are reasonably safe, in that the anaesthetic concentration can be rapidly reduced if necessary, by removing the mask. On the other hand, however, it is difficult to maintain an even plane of anaesthesia and it is wasteful, in that much of the anaesthetic is lost to the atmosphere which, as a result, becomes laden with the vapour. Other disadvantages include, the risk of injury to the face and eyes should any of the anaesthetic liquid come in contact with them, and, if respirations should stop, it is not easy, in large animals, to apply artificial respiration. Furthermore, the only anaesthetic agent which can be used in this

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Invstigations on Berenil Resistance to Trypanosomes.—*Concluded.*

resistance in a *congolense* strain by means of a diamidino-hydrazone.) The question, however, arises as to what extent resistance to Berenil is produced by Berenil itself, or whether a resistance is involved which has been indirectly induced by other drugs. Our experiments with mice described above seem to indicate that Berenil itself will not promote the development of resistant *Trypanosoma* strains even as a result of continuous administration in subtherapeutic doses. The experiment shown in Table I, in which no resistance occurs after 20 passages through mice receiving Berenil is, however, not absolutely conclusive. For the number of passages may have been insufficient, and furthermore, experimental results from mice—as shown among others in the studies of Soltys (1958) on antibody resistance—cannot be transferred without reservations to the conditions prevailing in large animals.

The results shown in Table II, according to which resistance to Berenil caused indirectly by some other drug was lost again after several passages through the mouse, in spite of continuous administration of Berenil, suggest that Berenil, itself, in contrast to other conventional anti-*Trypanosoma* preparations, does not promote the development of resistant *Trypanosoma* strains.

Resistance of strains of trypanosomes to other drugs including diamidines will persist for a long period. Fulton and Grant (1955), for instance, demonstrated this with stilbamidine.

In numerous passages through mice with continuous administration of stilbamidine the full resistance of the strain was maintained without any change at all. By continuous passages through mice without additional stilbamindine treatment, no change of resistance occurred for a period of 66 weeks. It was only in the 75th week (number of passages not mentioned) that a slight decrease of resistance could be observed.

We would like to draw the conclusion that all the various diamidines cannot be implicitly put on the same level as far as the development of resistant *Trypanosoma* strains is concerned.

The results so far reported of Berenil therapy under practical conditions do not indicate that resistant *Trypanosoma* strains will develop on account of the substance itself.

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way in large animals, is chloroform, and this agent is known to have toxic properties. Ether is not used, because it is difficult to build up a sufficient concentration of vapour; it was in order to overcome this difficulty that Henkels (1958) devised an "auto-inhalation" type of apparatus, where the volatilisation of ether was increased by means of hot water. Even if practicable, however, it would not be desirable to have such large quantities of an explosive and inflammable vapour in the atmosphere.

The new volatile anaesthetic "Halothane," has the required potency for administration to large animals in this way, but the expense of this agent prohibits its use in such an uneconomical way.

2. *Semi-closed method.* With this method, a selected mixture of gases and vapours are inhaled, from a reservoir bag, along wide-bore tubing, through a close-fitting mask, or wide-bore endotracheal tube. The exhaled gases pass to the atmosphere through an expiratory valve placed near the face of the animal.

This method enables a smooth, controllable level of anaesthesia to be attained, adequate oxygenation can be ensured and respirations can be easily seen by the movements of the reservoir bag. It is now used extensively in small animals, as a part of some "balanced anaesthetic" techniques (Hall & Weaver, 1954), but in large animals, the loss of all exhaled gases to the atmosphere through the expiratory valve, makes it too wasteful to be practicable.

3. *Closed and partially closed methods.* The agents used for inhalation anaesthesia are, in general, not only absorbed by the lungs but excreted by them as well, without having undergone any change in chemical composition. Because of this, it is possible, with the use of some of these agents, to collect the expired gases, pass them through soda lime, where the exhaled carbon dioxide is absorbed, and then allow them to be re-inhaled. This is done, by the use of "circle" or "to-and-fro" systems of apparatus and the methods are described as being "closed," because re-breathing is an essential feature of them. If the fresh gas inflow to such a system exceeds its capacity, as happens when nitrous oxide is used, then an intentional "spill-over" leak is arranged, and the system is described as being "partially closed." Where, on the other hand, a potent anaesthetic such as halothane or cyclopropane is used as the sole agent for maintenance, then, when anaesthesia is stabilised at the required level, the circuit can be completely closed, and only basal oxygen need be continuously fed into it.

These methods are also now extensively employed for "balanced anaesthesia" in small animals, giving similar advantages to the semi-closed method and, in addition, respirations can be completely controlled if this should be desired or become necessary, by manual compression of the re-breathing bag. Furthermore, since the same anaesthetic mixture can be continuously re-inhaled, considerable economy of the gases and vapours used can be exercised and it is for this reason that these methods would appear to be the ones most likely to provide the means by which the benefits of "balanced anaesthesia" might be extended to the larger animals.

Whereas, however, in the case of small animals standard human apparatus can be used, adult horses and cattle, for example, have a much larger lung capacity than adult humans; their resting tidal volume may vary from 1 to 6 litres, and their vital capacity may be as much as 30 litres. In the first place, therefore, more soda lime is required for these animals than for man, in order to remove all the carbon dioxide from exhaled gases and so the canister which contains the soda lime must be correspondingly larger. An equally important consideration is the fact that the internal diameter of the trachea of large horses and cattle measures 1 to 1½ inches, compared with a maximum of ¾ inch in man. If an animal has to breathe along tubes having a diameter less than that of its trachea, then considerable resistance is at once imposed on its respirations. The diameter of the breathing passages of standard human apparatus is rarely more than ¾ inch, and this, as has been stated by Fisher and Jennings (1957), is too small for large animals. When it is used with such animals, they soon showed increased respiratory effort due to the resistance and if allowed to continue, this would exhaust the animal and lead to inadequate pulmonary ventilation, with venous congestion and oedema of the lungs due to increased negative intra-pulmonary pressure.

Fisher and Jennings (1957) have reported on the successful use of a closed-circuit circle apparatus for adult cattle and horses, and in the United States of America the use of a to-and-fro closed-circuit apparatus for horses has been reported on by Reed, Allen, Glasser and Keefe (1957).

In this department in 1958, a circle system for use on large animals was improvised. This consisted of a uni-directional valve box placed near the head, industrial tubing having an internal bore of 1⅜ inch, a 5-gallon re-breathing bag, and a paraffin tin containing 4 lb. soda lime (Fig. 1).

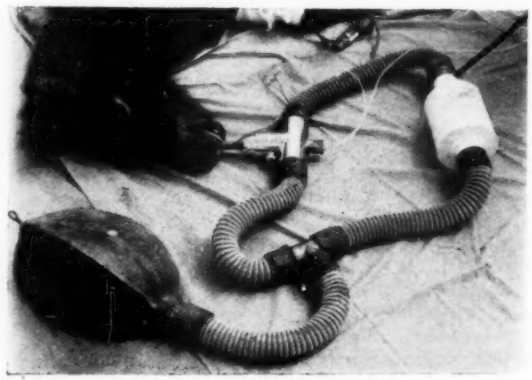

FIG. 1

More recently, however, a special apparatus has been made by Messrs. A. Charles King Ltd. (Fig. 2). This is a simple circle system and the gaseous passages through it are designed to be not less than 2

inches in diameter. Two sizes of re-breathing bags and soda lime canisters may be used on the circle, so that the ones appropriate to the size of the animal to be anaesthetised can be selected. One re-breathing bag has a capacity of 14,400 c.c., and the other has twice this capacity. The soda lime canisters contain either 3 lb. or 6 lb. of soda lime.

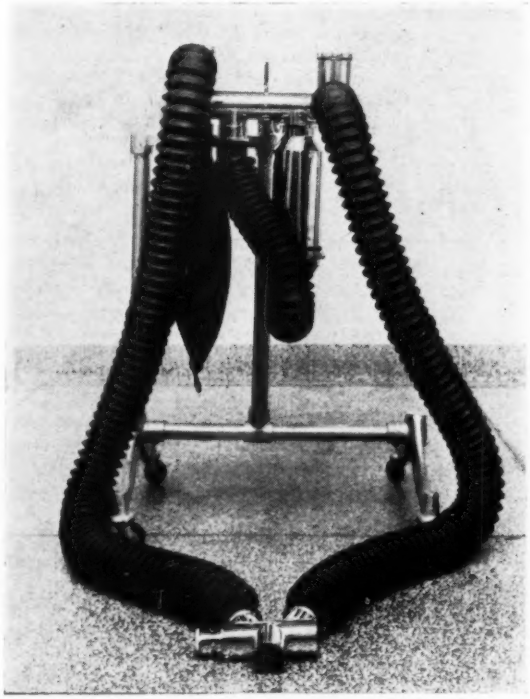

FIG. 2

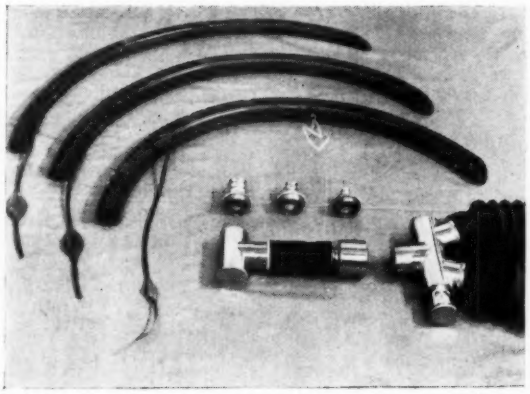

FIG. 3

Connexion of the circle to a series of large endotracheal tubes is made by means of a right-angled mount, into which can be screwed connexion heads to fit the various endotracheal tubes, as shown in Fig. 3. This arrangement is similar to that of the Beaver connexion system which is used with certain types of human apparatus. The large endotracheal tubes, each of which is fitted with an inflatable cuff, have also been made specially by Messrs. A. Charles King Ltd. The range of sizes are listed in Table I.

TABLE I
LARGE ENDOTRACHEAL TUBES

Number	Length	Internal diameter
1	24 in.	$\frac{9}{16}$ in.
2	27 ,,	$\frac{11}{16}$,,
3	30 ,,	$\frac{3}{4}$,,
4	30 ,,	$\frac{7}{8}$,,
5	33 ,,	1 ,,
6	33 ,,	$1\frac{1}{4}$,,

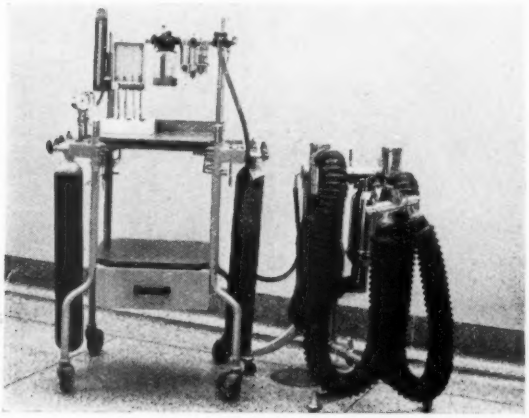

FIG. 4

Fresh gases are fed into the circle, either from a standard Boyles apparatus (Fig. 4), or from a King Portable apparatus which can be fitted to the trolly supporting the circle (Fig. 5). The circulation of gases through the circle can be seen from the working diagram of the apparatus (Fig. 6). The gases can be made to by-pass the soda lime canister, so that it can be removed and re-charged without interference to the concentration of anaesthetic being inhaled.

In addition to the use of this apparatus as a circle absorber, the soda lime canisters and re-breathing bags can be assembled for use as to-and-fro closed-circuit systems, if it is so desired (Fig. 7).

Use of the Apparatus

This apparatus has now been used on a number of animals as shown in Table II.

Fig. 8 shows the apparatus being used on a pony in the large-animal operating theatre, and Fig. 9 shows the assembly in a field, where it is being used on a large hunter gelding. Fig. 10 shows a cow anaesthetised for extirpation of an eye.

Mixtures of nitrous oxide/oxygen/ether, oxygen/halothane, oxygen/cyclopropane, or nitrous oxide/oxygen/halothane have been used. It was found

TABLE II

Species	No.	Range of body weights	Duration of maintenance of anaesthesia: Periods ranged between the times stated below
Equine	60	308—1,512 lb.	20 mins.—2 hrs. 30 mins.
Bovine	25	400—1,336 lb.	20 mins.—1 hr. 55 mins.
Swine	4	540— 756 lb.	45 mins.—1 hr. 18 mins.

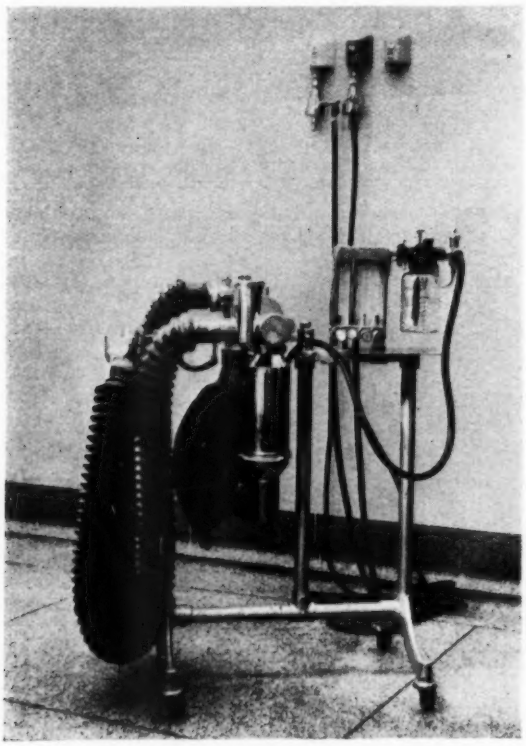

FIG. 5

possible to use ether for large animals in this way, as described by Fisher and Jennings (1957), but anaesthesia with this agent was not so satisfactory as it was with halothane, which has the additional great advantage of being non-explosive or inflammable.

Conclusion

The use of inhalation anaesthetic apparatus which is made suitable for large animals, means that they can be kept anaesthetised in a relaxed condition for surgery as long as desired. Operations can therefore be performed with much greater ease and precision than has hitherto been possible, and in addition, respirations can be assisted if necessary, while continuous oxygenation can be ensured. Moreover, by using inhalation anaesthetic agents for maintenance, the depth of anaesthesia can be easily varied, and the recovery period is shorter than when anaesthesia is maintained by non-volatile agents.

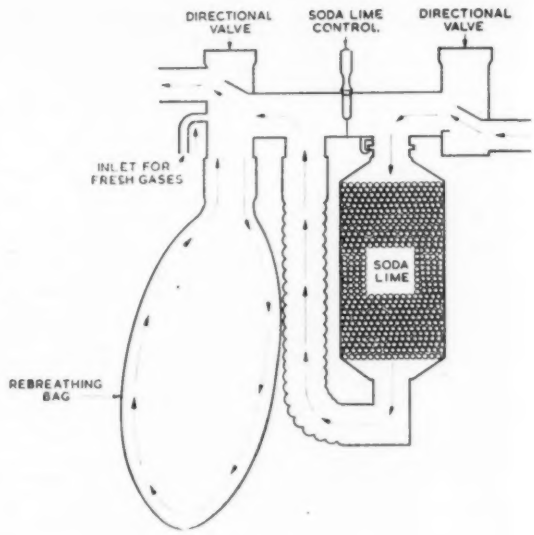

FIG. 6

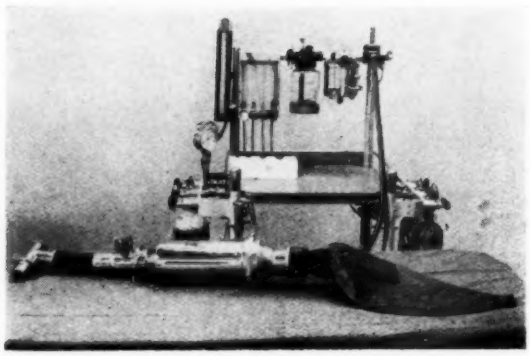

FIG. 7

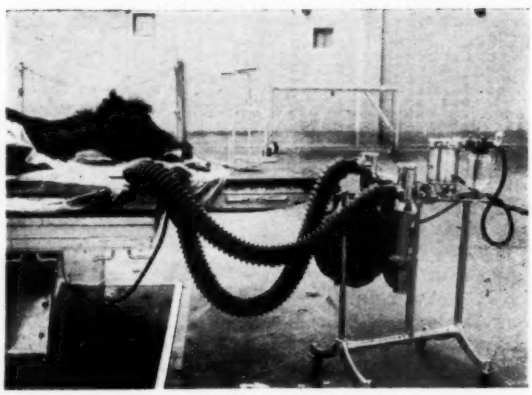

FIG. 8

A Case of Pneumo-peritoneum in a Pregnant Guernsey Heifer

BY

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Subject. A 2-year-old Guernsey heifer due to calve, bred and reared by the present owner.

History. The animal, which was only in fair condition, had been in perfect health until some 3 days before it was presented for examination when the owner noted some increase in abdominal size. This further increased during the succeeding 2 days—so much so that he described the animal as "being severely blown on both sides." During this period the heifer ate normally and was otherwise quite well.

Examination. The animal was able to stand but appeared depressed. The respiratory rate was increased, pulse rate was 70 per minute and the temperature 103.5. The most obvious feature was the enormous distension of the abdomen, particularly in the sub-lumbar fossae of both sides. Palpation of the left sub-lumbar fossa revealed an excessive peritoneal tympany such as is seen sometimes in cases of traumatic reticulitis. The air was not in the subcutaneous tissues but in the peritoneal cavity, as there was a gap of some 4 inches between the parietal peritoneum and the rumen which could be felt by deep digital palpation. Lower down in the left flank, some 4 inches behind the last rib, a hard object could be felt which moved when palpated. This, in spite of its unusual position, was thought to be the foetus. Palpation of the right flank presented a similar picture including the presence of a foetus. By using the fist and pummelling the abdomen from the ventral aspect a "sloshing" noise was heard as if fluid were present in the abdominal cavity. From the above it was apparent that the peritoneal cavity contained both fluid and gas as can be proved by a simple experiment. If a

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An Apparatus for Inhalation Anaesthesia in Large Animals.—*Concluded*

This approach then would appear to be a major advance towards the control of anaesthesia in large animals, *i.e.* the provision of ideal operative fields for the surgeon with maximum safety to the animal, and which has understandably so far progressed much farther in the dog and cat.

Acknowledgments.—The author wishes to acknowledge the facilities granted by Professor A. Messervy and to thank him for his encouragement.

The author's grateful thanks are due to Messrs. A. Charles King Limited for their helpful co-operation, for having made the prototype equipment and for the diagram (Fig. 6), in which its function is so clearly depicted.

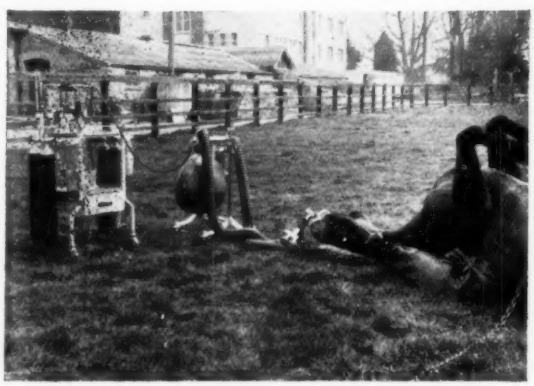

FIG. 9

The author is also indebted to Mr. M. Parsons for the photographs, and to Messrs. F. Gulson and V. C. Tindley of the Physiology Department of the Royal Veterinary College, London, for making the uni-directional valve box (Fig. 1).

Finally, the author wishes to thank the Totalisator fund for financial assistance which has been essential to the acquisition of special equipment.

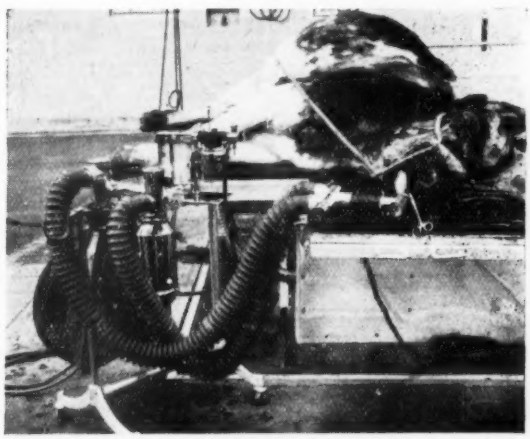

FIG. 10

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REED, W. C., ALLEN, C., GLASSER, M. E., & KEEFE, E. R. (1957). *Vet. Med.* **52.** 474

rubber hot-water bottle is filled with water to the exclusion of all air and then shaken no "sloshing" noises will be heard, but should some air remain in the bottle then shaking will produce the familiar sounds.

The vulval lips of the heifer were swollen and oedematous, the pelvic bones were relaxed and in these respects the animal resembled a normal pre-parturient bovine animal. However, the muscles of the gluteal region and of the back were tense and swollen and, if struck, resonated although there was no evidence of crepitation.

A vaginal examination revealed that the cervical seal was breaking down and that the cervix was relaxed enough to admit 2 fingers. Ballottement of the anterior vaginal wall revealed a foetus that moved, there was no evidence of foetal fluids, however. Rectal examination revealed nothing abnormal except the apparent absence of foetal fluids, the uterus being contracted on to the foetus, which was in anterior presentation, dorsal position. The foetus was alive as evidenced by a strong pedal reflex felt through the rectal wall.

Subsequently the apparent absence of foetal fluids was difficult to understand as the amniotic sac and fluid were normally disposed.

Diagnosis. Three possibilities came to mind:—

1. Clostridial infection of the abdominal cavity.
2. Hydro-allantois followed by uterine rupture.
3. Uterine rupture followed by aspiration of air into the abdominal cavity through an open cervix.

The first was ruled out because of the duration of the symptoms, the animal's well-being, and the absence of smell and of crepitation. The second condition was possible but did not account for the presence of air. Further, it is usual in cases of hydro-allantois to notice abdominal enlargement and possibly disorders of digestion after 7 months of pregnancy. In this case no such signs were noted. Hence a tentative diagnosis of uterine rupture was made.

Procedure. It was decided to examine the animal again 3 hours later at which time the cervix had opened no more. The respiratory distress due to the distended abdomen was becoming more serious and it was decided to proceed with an exploratory laparotomy and possibly with a caesarean section.

Operation. Left paravertebral anaesthesia of the last thoracic and first 3 lumbar nerves was undertaken using 20 c.c. 3 per cent. solution of w diethyl-acetanilide with adrenaline.*

The left flank was clipped, scrubbed and sterilised in the usual manner. An oblique incision was made along a line joining the brim of the pubis to the xiphisternum, first through skin then muscle layers and finally peritoneum. It was not until the latter was incised that gas escaped. The gas had no smell and was assumed to be air. It was allowed to escape slowly to lessen the shock to the animal. This took some 5 minutes and escaped for this period of time under its own pressure. The previously rotund animal now resembled a normal pre-parturient bovine.

*Xylotox, Willows Francis Ltd.

The rumen was now touching the abdominal wall and a hand passed down between the two could palpate the calf in the uterus. In the ventral part of the abdominal cavity could be felt a quantity of fluid which proved to be blood-stained and watery in nature. The presence of this and the somewhat unusual position of the calf decided the operator to proceed with caesarean section.

The skin, muscle and peritoneal incisions were lengthened to about 9 inches. Now there billowed from the incision a distended, balloon-like piece of tissue filled with air which at first appeared to be chorio-allantoic membrane but on closer examination was seen to be the superficial and deep parts of the greater omentum, the distension being due to gas in the omental cavity. This proved to be a most difficult piece of tissue to handle and both superficial and deep layers had to be incised before the uterine wall could be felt. By grasping the hock of the foetus through the uterine wall it was a fairly simple matter to bring this part of the uterus through the skin incision, although once out the foetus would kick violently thus tending to re-enter the warm abdomen.

Carefully the uterine wall was incised between the cotyledons until the allanto-chorion was exposed: this was carefully incised and there was no escape of fluid. It seemed to be attached loosely to the underlying membrane, the allanto-amnion, but could be separated from it by the fingers. No fluid escaped and it was concluded that the allantoic fluid was either absent or else had previously escaped to the peritoneal cavity. Incision into the allanto-amnion caused an immediate outflow of about a gallon of amniotic fluid, this being recognised by its thick, mucoid and lubricant nature. The foetus was removed and the umbilical cord severed. The calf was very much alive and to all appearances was normal. It was male.

The foetal membranes could not be removed. Two chlortetracycline oblets* were inserted into the uterus which was sutured with linen thread using a Lembert suture pattern. Before doing this, however, both an internal and an external search was made but no tear rupture or adhesions could be found. The skin, muscle and peritoneum were sutured together using 40 lb. braided nylon. An intramammary preparation of penicillin and streptomycin was applied to the skin edges. An intramuscular injection of 4 mega-units of procaine penicillin† was given and this was repeated the following day when the heifer was bright and had eaten hay and cake. The temperature was normal. On the second day the heifer released the complete foetal membranes without assistance. A week later the stitches were removed from the skin incision which had healed by first intention. There was some uterine discharge and another oblet was inserted. The heifer was giving enough milk to rear 3 calves. Subsequent recovery was uneventful.

* Aureomycin soluble oblets 500 mg., Cyanamid of Great Britain Ltd.

† Veterinary mylipen, Glaxo Laboratories.

(*Concluded at foot of page opposite*)

Current Literature

BOOK REVIEWS

Modern Veterinary Practice. Reference and Data Service. American Veterinary Publications Inc., Wheaton, Illinois.

Of its kind, this is one of the most impressive works which we have seen for some time. It is a monthly publication and consists entirely of abstracts from the current veterinary journals of the world. THE RECORD is well represented.

Two well made quarto binders are provided. These are bound in tough plastic; one is red for large animal abstracts and the other dark blue for small animals. Each binder is divided into sections and sub-sections by separating sheets. These carry thumb tags which provide a general index. Apart from this, a cumulative index is published twice a year. The large animal abstracts are divided into 5 sections: cattle, swine, sheep, horses, and miscellaneous. The cattle section is subdivided into contagious, metazoal, metabolic, toxic, technics, and general. Other sections are treated in the same way. Every sheet has a code to show where it should be filed and the pages in a sub-section are numbered consecutively. Each edition is sent out as a packet of loose sheets with a perforated margin for binding. After 9 months, the binders now contain some 750 pages. There is no section on poultry.*

It is clearly the intention that practitioners who read the abstracts should be saved the trouble of reading the original. This has been successful to a great extent and we are probably told as much as we are likely to remember for any length of time. McTaggart's article on "Milk Lameness" covered 5 pages of THE RECORD in October, 1959. The abstract, in January, 1960, covering two-thirds of a page, offers a remarkably clever summary of what was said. Roberts and Vallely wrote 4 pages in THE RECORD on "Haemolytic *E. coli* in pigs." This is abstracted on half a page. Naturally much which is of value is lost by this system but few of us have the time to read all the journals. This publication will keep us informed on all that is going on.

The technical editor is Mr. D. W. Jolly, M.R.C.V.S., who left Britain to take up this work. He is well known to many of the profession in this country and served, for a time, on the Editorial Committee of THE VETERINARY RECORD.

* We are advised that the omission of a section on poultry was deliberate, since the American poultry industry has its own specialised veterinary service: the average American veterinary surgeon has, therefore, little interest in poultry and a decision was made not to include abstracts on poultry matters.—EDITOR.

Fundamental Aspects of Normal and Malignant Growth. W. W. Nowinski, Editor. D. Van Norstrand & Co. Ltd., London (1960). 220s.

In his over-brief preface to this fascinating book, the editor writes that "the intention was that it should be an introduction into various aspects of the growth problem, a kind of stepping stone from which—on the basis of ample references—the reader would be able to go deeper into details of the problems in which he is particularly interested." It would have enabled the potential reader to grasp the scheme and scope of the book better had the editor—whose own contribution (subject unspecified) could not be included "owing to lack of space" (it will appear as a separate book from the same publishers)—included, either in an extended preface, or as an introductory chapter, a more detailed consideration

A Case of Pneumo-peritoneum in a Pregnant Guernsey Heifer.—*Concluded*

The heifer would have nothing to do with the calf after it had been taken from the uterus; it would neither lick it nor attempt to attack it. It was wondered if it was essential to have some pelvic stimulation before the natural instincts could be brought into play. The calf was given 60 c.c. of its mother's blood subcutaneously, and it was fed colostrum from its mother in a feeding bottle. For 2 days it was kept by the kitchen fire and by that time it had learnt to feed from a bucket and was able to join the other calves in the calf pens. It was reared and sold as a veal calf.

Discussion. One can only surmise what occurred in this heifer. The facts indicate that the peritoneal cavity contained a large quantity of gas under pressure and also a quantity of sanguineous fluid; there appeared to be an absence of allantoic fluid in the allantoic cavity. The condition did not recur subsequent to the operation and therefore seems to have been associated in some way with the pregnancy.

A possible explanation is that the uterus and allanto-chorion ruptured and resulted in the outpouring of the allantoic fluid. The hole being a small one caused no further complications except that there was now a connexion between the peritoneal cavity and the atmosphere by way of the partially open cervix. Movements of the diaphragm could now easily aspirate air into the peritoneal cavity and this could not escape again owing to the valve-like nature of the uterine tear. The rupture must have occurred at a point where the allanto-chorion is not fused to the allanto-amnion, that is to say, near to the extremities of the foetal membranes.

If, as seems likely, the calf was deprived of its allantoic fluid 3 days before birth, this indicates that at least in this case it is not an essential factor in the maintenance of pregnancy.

Other cases of uterine rupture that have been reported in advanced pregnancy recently have resulted in the foetus being found in the abdominal cavity but there has been no report of excessive gas formation as in this case, previously only large quantities of fluid have been found.

of what the book is about, bringing the rather vague phrase "growth problem" into sharper focus. One further small criticism can perhaps be directed at the editor—the reviewer has noted some 20 misprints, mostly in the index.

Having said this much, however, it can be freely admitted that this is an immensely interesting and informative book. Many experts (11 from America, 2 from Belgium, 1 from England) contribute detailed and critical surveys of their chosen subjects, and these chapters, with their lengthy bibliographies, will be of great interest to all who are concerned with growth, chiefly in its biochemical and morphological aspects —whether biologists, biochemists, embryologists, pathologists, or cancer research workers. The scope of the various discussions is both broad and deep, and they are calculated to give the worker in one field a well-informed and forward-looking view of the situation in other fields.

With a book of this size, and of such a range of subjects, the reviewer does not feel competent in any case to criticise more than a few of its chapters, and he will therefore content himself with noting what the various chapters are about, and merely record his own pleasure in reading the book.

The various chapters are as follows:—

1 (136 pages): S. Kit on "Intermediary metabolism of building blocks involved in growth." This is concerned with the various energy-yielding metabolic cycles of the cell, and the biosynthesis of the major building blocks of protoplasm. There is also provided (in a pocket inside the back cover of the book) a handy metabolic chart, which shows, in a sort of gigantic "Underground" map, the metabolic pathways in the cell.

2 (123 pages): L. von Bertalanffy on "Principles and theory of growth," developing various growth equations.

3 (45 pages): J. Brachet on "Nucleic acids and growth," with particular reference to DNA and mitosis and RNA and protein synthesis.

4 (190 pages): A. Dalcq on "Germinal organisation and induction phenomena," largely concerned with intrinsic and extrinsic morphochoresis—the latter, a term roughly equivalent in meaning to "early morphogenesis."

5 (51 pages): H. Hermann on "Molecular mechanisms of differentiation: an inquiry into the Protein Forming System of developing cells," with particular reference to differentiation and embryonic development.

6 (42 pages): Charity Waymouth on "Growth in tissue culture," first pointing out the traps set for the unwary by these apparently straightforward words.

7 (76 pages): A. E. Needham on "Regeneration and growth."

8 (48 pages): W. W. Washburn, Jr., on "Wound Healing as a problem of growth."

9 (36 pages): Hugh Clark on "Nitrogen metabolism and growth," in relation to aspects of development up to organogenesis.

10 (75 pages): K. V. Thimann on "Plant growth."

11 (54 pages): A. Kirschbaum on "The carcinogenic stimulus."

12 (49 pages): A. C. Griffin on "The metabolism of the cancer cell."

13 (26 pages): J. J. Biesele on the "Action of certain anti-metabolites as mitotic poisons."

14 (21 pages): W. Andrew on "Growth and the ageing process."

Throughout the book, the authors are not content merely to give factual accounts of their subjects, but they try to show the broader significance and correlations of the facts.

The book is very well produced, and the price is not unexpectedly high.

News and Comment

THE FOOT-AND-MOUTH OUTBREAK

The Foot-and-Mouth Controlled Area restrictions which had been in force in Scotland south of the Caledonian Canal were withdrawn at midnight on Wednesday, November 23rd. The County of Orkney remains a Controlled Area and *the normal Infected Area Restrictions remain in force in the neighbourhood of all confirmed outbreaks of disease.*

A Ministry notice issued on November 25th stated:—

Within the past 24 hours disease has been confirmed in Nottinghamshire, Essex and Shropshire which cannot be connected with earlier outbreaks.

A controlled Area Order has, therefore, been made affecting the following counties, with effect from midnight, November 25th:—

Bedfordshire, Berkshire, Buckinghamshire, Cambridge, Cheshire, Derbyshire, Essex, Flintshire (Petty Sessional Division of Overton only), Herefordshire, Hertfordshire, Huntingdonshire, Isle of Ely, Lancashire (except Furness), Leicestershire, Lincolnshire (Lindsey, Kesteven and Holland), London, Middlesex, Norfolk, Northamptonshire, Nottinghamshire, Oxford, Rutland, Shropshire, Soke of Peterborough, Staffordshire, Suffolk, Warwickshire, Worcestershire and the East and West Ridings of Yorkshire.

Sir Anthony Hurd, chairman of the Conservative agriculture committee, has asked the Minister of Agriculture to say what action the Ministry has taken to discuss with South American governments precautions against the export to Britain of meat carrying the infection of foot-and-mouth disease.

In a written reply to Sir Anthony Hurd, the Minister of Agriculture said that during the five years to 1959 his department had attributed 62 primary outbreaks of foot-and-mouth disease to infected South American meat and 46 to infection brought from the Continent, probably by birds. The origin of the

remaining 12 outbreaks, added Mr. Soames, was obscure.

In a further reply Mr. Soames stated that "there is still no evidence that the present series of outbreaks can be definitely attributed to the use of infected swill or waste food" and "it now seems unlikely that the origin will be discovered because of the passage of time."

The B.B.C. has started a daily information service for farmers at 6.40 a.m. giving the latest information on the epidemic. The total number of outbreaks is reported to be 200, with 39,425 animals slaughtered.

THE THOMAS BAXTER PRIZE

The President of the B.V.A., Mr. Sydney Jennings, was present at a luncheon held in the Cafe Royal, London, last Tuesday, when the Thomas Baxter prize was awarded to Dr. K. L. Blaxter of the Hannah Dairy Research Institute.

The luncheon was organised by the *Farmer and Stock-breeder*, with Sir Richard Haddon presiding. The guest of honour, who presented the award, was the Minister of Agriculture.

INCREASED CHARGES FOR POST-MORTEM EXAMINATIONS OF POULTRY

From December 1st, 1960, the fees payable for *post-mortem* examinations of poultry at the Ministry's Veterinary Laboratories has been raised from 3s. 0d. to 12s. 6d. per report on adult birds and growers over 4 weeks of age, and from 5s. 0d. to 17s. 6d. per report on batches of chicks up to 4 weeks of age. The free service to members of the Poultry Stock Improvement Plan will be continued.

The present scale of fees has remained unchanged since the service was introduced in 1925. The poultry industry and the professional bodies concerned were consulted about the proposed changes, and their suggestion that full fees should be introduced in two stages has been adopted.

The Ministry will continue to carry out examinations for veterinary surgeons free of charge in cases where they need the advice of the Veterinary Investigation Service to solve a difficult problem, *e.g.*, where a differential diagnosis is required. A veterinary surgeon wishing for such advice, must, however, send a letter with the specimen stating the steps he has taken to deal with the problem himself.

HISTORY OF THE ROYAL ARMY VETERINARY CORPS

The following additional donations have been received:—

Major C. D. Hopkins, M.R.C.V.S., 2 gns.; Major C. Davenport, O.B.E., M.R.C.V.S., 2 gns.; Major E. Wallace, M.R.C.V.S., 2 gns.; Major G. K. Shaw, M.R.C.V.S., £10.

THE ROYAL COLLEGE OF VETERINARY SURGEONS

We are happy to say that Mr. J. N. Ritchie has returned to active duty, both as Chief Veterinary Officer and as President of the Royal College.

His first function as President, was on Monday last, to receive for the last time in the old College building the President and the Officers of the British Veterinary Association accompanied by the General Secretary. It was singularly appropriate that this, the last official reception in the old building, should be for representatives of the British Veterinary Association for it was at No. 10 Red Lion Square, on Friday, October 27th, 1882, that a committee of veterinarians, under the chairmanship of the then President of the College, G. Fleming, C.B., LL.D., resolved to found an association under the name of the National Veterinary Association.

There have been a number of distinguished visitors to the College buildings during the last weeks: these included, from the Ministry of Agriculture, the Permanent Secretary, Sir John Winnifrith, the Deputy Secretary, Mr. G. S. Bishop, the Under Secretary, Mr. J. Hensley, and the Assistant Secretaries of the Animal Health Division and the Food Standards Division, Mr. Quick, and Mr. Compton.

From the Colonial Office came the Under Secretary of State, Sir Hilton Poynton, and from the Privy Council, the Clerk, Mr. W. G. Agnew.

There have been many other visitors, both of the profession and associated with the profession including Mr. Alec Hobson, of the Royal Agricultural Society of England, and Mr. Salter Chalker, of the National Farmers' Union.

TO-MORROW'S TELEVISION BROADCAST

The "television vet" is appearing on the B.B.C. television farming programme at 12.40 p.m. tomorrow (December 4th). Once again he has kindly sent to the Editor an advance copy of his script in order that members who do not see the programme, will have a general idea of what is said.

The general tenor of the talk is on the value of hospitals for large-animal patients. There will be shown on the television screen a Friesian cow arriving for a major abdominal operation. The "television vet" will illustrate his confirmatory diagnosis, followed by anaesthesia, and then the surgical sequence. From the script it appears that this will be illustrated in full detail up to the closure of the wound.

The speaker will then refer to the checking of his diagnosis by laboratory methods, after which he will revert again to the value of hospital facilities, including the time saved by not having to pay several visits to a patient. There will follow an illustrated discourse, describing fertility testing in a bull, the examination of a case of husk, the amputation of a sow's claw, and, finally, a minor operation on a cow. The "television vet" refers to this hospital sequence as "a peep into the future," and expresses his view that hospitalisation will steadily increase.

MR. HUW EIRWYN PRYTHERCH

It is with deep regret that we record the death of Mr. Huw Eirwyn Prytherch, M.R.C.V.S., at his home, the Laurels, Pensarn, Abergele, on November 15th, 1960.

Mr. Prytherch was 45. A native of Anglesey, he was a veterinary student at Edinburgh and qualified

in July, 1939. He took over the practice in Abergele in 1941, later becoming senior partner in the firm of Prytherch and Morris. Of a quiet and kind disposition, Mr. Prytherch was very popular among his professional friends in North Wales, and he was a prominent member of the North Wales Division, B.V.A., serving in the capacity of hon. auditor since 1954, and more recently as a member of the Council of the Division.

The funeral took place at Abergele, on November 18th. The profession was very well represented, and the North Wales Division was officially represented by Mr. R. W. Pritchard (vice-President) and Mr. C. W. Cartwright (treasurer).

Mr. Prytherch will be greatly missed in North Wales, and we extend our deepest sympathy to his widow and two children.

MR. LOUIS GOVAERTS

Mr. M. Berwyn-Jones writes:—

I read the obituary notice of fellow student Louis Govaerts with the deepest regret. It did not surprise me, as I heard that he was suffering from cancer early in the summer. But it has surprised me that someone who knew him well (which I did not) has not paid tribute to him. It is a tragedy when a life is taken by such a horrible disease, but when it takes from us someone as young and energetic as Louis Govaerts, it is beyond words. I would like to convey my deepest sympathy to his relatives on behalf of his many friends.

MR. H. M. WILSON HONOURED

Mr. Harry M. Wilson of Cupar, Fife, attended Buckingham Palace last week to receive the O.B.E. He is seen here outside the Palace with his wife.

THE UNIVERSITY OF LIVERPOOL

The Departments of Veterinary Anatomy and Veterinary Pathology will be vacating their old premises in Bedford Street North, and will move into the new veterinary building which is nearing completion during the month of December.

The Department of Veterinary Pathology announces that it will be unable to accept material for examination between the dates of December 5th, 1960, and January 7th, 1961.

BINDING "THE VETERINARY RECORD"

A reader advises us of the service, in this connexion, of Messrs. Cedric Chivers Ltd., of Portway, Bath, who bind volumes of our journal at a cost of 29s. plus 3s. 3d. postage. We understand that the charge of 35s. made by our own printers includes the cost of postage. If any reader knows of a cheaper binding we should be pleased to make the address known for the benefit of others.

SUPPLEMENT TO "THE VETERINARY RECORD"

As readers may recall, the Council of the B.V.A. has decided that THE SUPPLEMENT will cease to be published after the end of this year, and that its contents will appear in THE VETERINARY RECORD thenceforward. One more SUPPLEMENT is in preparation to complete the volume for 1960, and hon. secretaries of Divisions are asked to be good enough to forward to the Editor any material they would like to have published in THE SUPPLEMENT, *not later than December 10th.*

PERSONAL

Engagement

THURLEY—HOUSE.—The engagement is announced between Thomas Manley Thurley, M.R.C.V.S., son of Mr. and Mrs. M. M. Thurley, of London, W.7, and Rachel House, daughter of the late Mr. Humphry House and Mrs. House, Cambridge.

Births

BAIRD.—On October 27th, 1960, to Sheila (*née* Park), wife of A. C. Baird, M.R.C.V.S., 40 York Place, Edinburgh, a son, Mungo Park, brother for Colin and Marion.

DOWN.—On November 14th, 1960, to Diana (*née* Sycamore), wife of Bryan Down, M.R.C.V.S., of Malmesbury, Wiltshire, a daughter, Sarah, sister for Nicholas.

EAGLESOME.—On November 1st, 1960, to Edith (*née* Howie), and Matt. D. Eaglesome, B.V.M.S., M.R.C.V.S., of Kingswood, Wotton-under-Edge, Gloucestershire, a daughter, Hazel Anne.

FAWELL.—On November 8th, 1960, at the Maternity Hospital, Fulford, York, to Vera, wife of Ernest V. Fawell, M.R.C.V.S., twin daughters, Elizabeth and Sheila.

R.C.V.S. OBITUARY

We record with regret the death of the following member of the profession:—

LAWTHER, James (Capt. late R.A.V.C.), of Downpatrick, Co. Down, Northern Ireland. Graduated Glasgow, December 13th, 1906. Died November 20th, 1960, aged 77 years.

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COMING EVENTS

December

7th (Wed.). LAKELAND VETERINARY ASSOCIATION. Meeting at the George Hotel, Penrith, 6 p.m.

CORNWALL VETERINARY CLINICAL CLUB. Annual General Meeting at the Red Lion Hotel, Truro, 7.30 p.m.

8th (Thurs.). ESSEX VETERINARY SOCIETY. Meeting in the Judges Room at the Saracen's Head, Chelmsford, 7.30 p.m.

EAST MIDLANDS DIVISION. Joint Meeting with the Staffordshire & Derbyshire Veterinary Club at the Royal Hotel, Ashby-de-la-Zouch, 8 p.m.

9th (Fri.). BRITISH VETERINARY POULTRY ASSOCIATION. 14th Meeting of the Association at Unilever House, London, 2.15 p.m.

SOUTH WALES DIVISION. General Meeting at the Park Hotel, Cardiff, 2.15 p.m. Meeting of the Ladies' Guild at the same address, 3.30 p.m.

11th (Sun.). SOUTH EAST MIDLANDS VETERINARY ASSOCIATION. Joint meeting with the Kettering and District Medical Society at the George Hotel, Kettering, 7 p.m.

14th (Wed.). SUSSEX VETERINARY SOCIETY. Meeting at the Old Ship Hotel, Brighton, 2.30 p.m.

WEST OF SCOTLAND DIVISION. Meeting at the University Veterinary Hospital, Bearsden, 7.30 p.m. B.S.A.V.A. NORTH EASTERN REGION. Meeting at the Queen's Hotel, Leeds, 1, 8 p.m.

15th (Thurs.). WESTERN COUNTIES VETERINARY ASSOCIATION. Meeting at the Rougemont Hotel, Exeter, 2.30 p.m.

SOUTH EASTERN VETERINARY ASSOCIATION. Meeting at the Royal Star Hotel, Maidstone, 2.30 p.m.

TECHNICAL DEVELOPMENT COMMITTEE

The next meeting of the Technical Development Committee will be held at 7, Mansfield Street, London, W.1, at 10.30 a.m. on Monday, December 5th, 1960.

ADDRESSES OF DISEASE INFECTED PREMISES

The list given below indicates, first the county in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

Anthrax

Aberdeen. The Shiel, Leochel, Cushnie, Alford.
Angus. Balruddery Farm, Invergowrie (Nov. 28).
Ches. Noonday Poultry Farm, Edge, Malpas (Nov. 21); Ivy Bank Farm, Mickle Trafford, Chester (Nov. 28).
Leics. Home Farm, Church Langton, Market Harborough (Nov. 24).
Salop. Sandy Lane, Prees, Whitchurch (Nov. 22).
Somerset. Hempton Court Farm, Hempton Lane, Patchway, Bristol (Nov. 21).

Foot-and-Mouth Disease

Aberdeen. Kings Seat Farm, New Machar (Nov. 21); East Back Hill, Ardallie, Mintlaw, Mintlow Station (Nov. 23); Overton Croft, Dyce; Upper Kirkton, Dyce (Nov. 24); Upperton, New Deer (Nov. 25); Chapelhall Farm, Chapleton Farm, Udney (Nov. 28).
Ayr. Third Part, Skelmorlie (Nov. 23); Barr Farm, Skermorlie (Nov. 25).
Durham. Hylton Bridge, West Boldon (Nov. 22).
Essex. Willow Farm, Wennington, Rainham (Nov. 24).
Fife. Spittal Farm, Cardenden (Nov. 25).
Lanarks. Netherinch Farm, Milton of Campsie (Nov. 21); Cormiston Farm, Biggar (Nov. 23); Leggrannock, Newart Hill, Motherwell (Nov. 24); City Abattoir, Glasgow (Nov. 25).
Norfolk. Hall Farm, Swardeston, Norwich; Wicken Farm, Castleacre, King's Lynn (Nov. 21); Manor Farm, Saxlingham, Norwich (Nov. 22); High House Farm, Tibenham, Norwich (Nov. 23); Besthorpe Hall, Besthorpe (Nov. 24); The Limes, Scole, Diss; Grove Farm, Saxlingham, Norwich (Nov. 25); Hall Farm, Saxlingham Green, Norwich (Nov. 28).
Northumberland. Hollinside Farm, Whickham, Newcastle upon Tyne (Nov. 22); South Farm, Hallington, Newcastle upon Tyne (Nov. 23); Dewley Farm, Throckley, Newcastle upon Tyne; Fell House Farm, Walbottle, Newcastle upon Tyne; East Farm, Berwick Hill, Ponteland, Newcastle upon Tyne (Nov. 28).
Notts. Bank Hill Farm, Woodborough; Holbeck Farm, Oxton Road, Southwell; Firs Farm, Holme Pierrepont, Nottingham (Nov. 21); Bessenger Farm, Edingley, Newark (Nov. 22); Lodge Farm, Fiskerton, Newark (Nov. 23); Burns Farm, Church Warsop, Mansfield; Park House Farm, Bothamsall, Retford; Thoresby Home Farm, Perlethorpe, Newark (Nov. 24); Mount Milner Piggeries, Mansfield (Nov. 25); Mill Farm, Farnsfield, Newark (Nov. 26).
Orkney. Brough Farm, Toab, Kirkwall, Langscaill, Tankerness, Kirkwall (Nov. 22); Faverock, St. Ola, Kirkwall; Attested Yard, Junction Road, Kirkwall; Nist House, Evie, Kirkwall (Nov. 23); Fletts Field, The Aerodrome, St. Ola, Kirkwall (Nov. 25); Garth, Quholm Stromness; Hall of Clestrain, Orphir, Kirkwall (Nov. 27).
Renfrew. Borough Slaughterhouse, Greenock (Nov. 22)
Salop. The Beeches, Ollerton, Market Drayton (Nov. 24)
Suffolk. Uplands Farm, Gillingham, Beccles (Nov. 21).

Fowl Pest

Bucks. Levenden Road Farm, Olney (Nov. 28).
Essex. Northlands, Dry Street, Langdon Hills, Basildon (Nov. 25); Garryowen Poultry Farm, Horndon-on-the-Hill (Nov. 26); Chentilly, Noak Hill Road, Billericay (Nov. 28).
Herts. Swan Street, Ashwell, Baldock (Nov. 26).
Norfolk. Mill Farm, Hockering, East Dereham; Prospect House, Methwold, Thetford (Nov. 21); Laburnham Farm, Bodham, Holt; Coston Hall, Barnham Broom, Wymondham; Holding, Friarcroft Lane, Wymondham; Rose Cottage, Mill Lane, Tunstead; 2, Long Row, The Lizzard, Wymondham (Nov. 22); Village Farm, Honingham, Norwich; Home Farm, Reddenhall, Harleston; Woodthorpe Farm, Winfarthing, Diss; Cherrydrift, East Dereham; Rectory Road, Sutton Smallburgh, Norwich; Flybarn, Stow Bedon, Attleborough (Nov. 23); Howards Close, Trunch, North Walsham; Hill Farm, Barford, Norwich; Fen Farm, Banham, Norwich; Hall Park, Hockwold, Thetford; Hill Farm, Attleborough; No. 2 Site, Hardwick Road, Starston; Mill Road, Fleggburgh, Great Yarmouth; Crows Lane, Little Plumstead Norwich; Hunts Farm, New Buckenham, Norwich; Horseshoe Cottages, Upper Weybread, Diss; Ferry Farm, Hockwold, Thetford; Lodge Farm, Buxton, Norwich; Ivy Farm, Tharston, Old Buckenham, Attleborough; Hill House, Upper Weybread, Diss; West Park Farm, Ickburgh, Thetford (Nov. 26); Hill House, Colney, Norwich (Nov. 27); Rookery Farm, Besthorpe, Attleborough; 29, Mill Road, Little Melton, Norwich; White Bungalow, Southburgh, Thetford; White House Farm, Starston, Harleston; 8, Vicarage Road, Norwich (Nov. 28).
Somerset. Bridge Farm, Stoke-under-Ham, Yeovil (Nov. 23); Portway Farm, Marston Magna, Yeovil (Nov. 24); Royal Naval Air Station, Yeovilton, Yeovil (Nov. 28).
Salop. 24, Bowley Common, Bowley Stanton (Nov. 24).
Suffolk. Dairy Farm, Woodton, Bungay; The Heath, Thurston, Bury St. Edmunds; Driftway, Linstead Magna, Halesworth (Nov. 21); The Street, Culford, Bury St. Edmunds; Park Cottages, Drinkstone, Bury St. Edmunds; Bergholt House, Fornham All Saints, Bury St. Edmunds; 25, Tollgate Lane, Bury St. Edmunds; Homestead, West Stow, Bury St. Edmunds (Nov. 22); Catkin Farm, Linstead Magna, Halesworth (Nov. 25); Mill Lane, Exning, Newmarket; Duchess Drive, Cheveley, Newmarket (Nov. 26).
Surrey. Whitelands Farm, Newdigate, Dorking (Nov. 24); Ellis Place, Worplesdon, Guildford; Woodlands, Cudworth Lane, Newdigate, Dorking (Nov. 25).

XUM

Swine Fever

Ches. Heath Farm, Chester High Road, Burton, Neston, Wirral (Nov. 22).

Derby. Overdale, High Road, South Wingfield (Nov. 22).

Devon. West Barton, Nymet Rowland, Crediton (Nov. 21).

Durham. Brinkburn Road Allotments, Darlington (Nov. 23); Moor House Farm, Stillington (Nov. 24).

Essex. The Piggeries, Leaden Roding, Dunmow (Nov. 21); The Shrubbery, Leighams Road, Bicknacre, Chelmsford (Nov. 23).

Flints. Well House Farm, Padeswood, Mold (Nov. 23).

Glam. Llanant Farm, Penyrhoel, Gorseinon, Swansea (Nov. 22).

Hants. Home Farm, Cadnum, Southampton (Nov. 23); Wade Court Farm, Havant (Nov. 25.

Kent. Lamberden Farm, Newenden, Hawkhurst (Nov. 21).

Lancs. Oak House, Grape Lane, Croston, Preston (Nov. 23); Pinch Farm, Knott Lanes, Bardsley, Oldham; Orchard Dene, Kirkham Road, Freckleton (Nov. 24); Snub Snape Farm, Altcar Lane, Leyland, Preston (Nov. 25).

Leics. The Bungalow, Fosse Road, Upper Broughton, Melton Mowbray (Nov. 21).

Lincs. Grange Farm, Laughton, Gainsborough (Nov. 23); Trentside Farm, Althorpe, Scunthorpe (Nov. 25).

Norfolk. Rose Farm, Hingham Road, Great Ellingham, Attleborough (Nov. 21); Fernbank, The Moor, Reepham, Norwich; Church Hill Farm, Winfarthing, Diss (Nov. 28).

Northants. 2, Folksworth Road, Folksworth, Peterborough (Nov. 22).

Notts. 9, Wharf Road, Pinxton (Nov. 23).

Salop. Brook Farm, Tybroughton, Whitchurch (Nov. 21); Belton Farm, Whitchurch; Mayfields Farm, Barkers Green, Wem, Shrewsbury (Nov. 23); Quoisley Farm, Quoisley, Marbury, Whitchurch (Nov. 24); Bettisfield Hall, Bettisfield, Whitchurch (Nov. 25).

Suffolk. Punchards Farm, Rattlesden, Bury St. Edmunds (Nov. 24); Hurdle Drove, West Row, Bury St. Edmunds (Nov. 28).

Warwicks. Foxhill Farm, Alvechurch, Birmingham (Nov. 21).

Yorks. Birijik Farm, Woodhall Way, Moescroft, Beverley; Village Farm, Appleton Wiske, Northallerton (Nov. 21); Orchard House, Melsonby, Richmond; Rillington Fields, Rillington, Malton; Carlton Green Farm, Aldborough St. John, Richmond; Snape Park, Snape, Bedale (Nov. 23); Pallet Hill Farm, Catterick, Richmond (Nov. 25); Aiskew Grange, Leeming Bar, Northallerton; Field House, Beeford, Driffield (Nov. 28).

Letters to the Editor

The views expressed in letters addressed to the Editor represent the personal opinions of the writer only and their publication does not imply endorsement by the B.V.A.

SCIENTIFIC

Polioencephalomalacia in Calves

Sir,—In 1956, Jensen, Griner and Adams reported a disease of unknown aetiology affecting cattle and sheep in the U.S.A. They called this disease polioencephalomalacia. Symptoms of the disease included twitching of the muscles of the head, bilateral impairment of vision and paralysis. The course varied from one to several days. Mortality varied from 50 to 90 per cent.

Macroscopic examination of the brain from acute cases revealed multiple yellow foci of necrosis throughout the cerebral cortex. In recovered animals the brain was small. In some areas the cortex had been completely removed and in other areas cysts were present. In the acute cases a histopathological examination revealed necrosis of neurones, proliferation of endothelial cells, accumulation of gitter cells and gliosis at the junction of viable and necrotic tissue. In recovered animals empty spaces and cysts were surrounded by gliosis.

The purpose of this letter is to record, we think for the first time, the occurence of a similar syndrome in calves in England.

In October we received the head of a 5-month-old Hereford steer from Mr. Peter Wild, B.V.SC., M.R.C.V.S., of Alfreton. This animal had been slaughtered after an illness lasting for 6 days. During this time it showed twitching of the muzzle, apparent blindness "although the eyes appeared normal," opisthotonus and recumbency.

Three other cases were sent to us by Mr. J. Greenwood, B.V.SC., M.R.C.V.S., of Ormskirk. These 3 animals were 5-month-old heifers, and came from the same farm. The first was an Aberdeen Angus that died on October 3rd, 1960, after an illness lasting for 6 days. The second was a Friesian that was destroyed when recumbent on November 3rd, 1960, after an illness lasting for 3 days. The third heifer, the twin of the second case, died on November 13th, 1960, after an illness lasting for 3 days. All these animals were seen to be refusing their food for one day before becoming apparently blind, bumping into objects, and finally lying with limbs stiffly extended and head drawn back over the withers. The second animal also showed convulsions.

All 4 animals had the macroscopic and histological lesions of polioencephalomalacia. It is hoped to record these findings in more detail at a later date.

Yours faithfully,
J. McC. HOWELL.

The University of Liverpool,
Department of Veterinary Pathology,
42-44 Bedford Street North,
Liverpool, 7.

November 24th, 1960.

Reference

JENSEN, R., GRINER, L. A., & ADAMS, O. R. (1956). *J. Amer. vet. med Ass.* **129**. 311.

GENERAL

V.V.B.F. Christmas Appeal

Sir,—It is usual at this time of the year to remind readers of the Christmas Gift Account, for it is from this Account that we are enabled to give aged or infirm members or their widows (some with young children) a monetary gift so that they too may have a more enjoyable Christmas.

We therefore appeal to all who read this letter to show their interest and support of this good work by kindly sending at an early date a donation, however small, to the secretary, V.V.B.F., 10 Red Lion Square, London, W.C.1.

If, on the other hand, readers would prefer to send a small Christmas parcel to one of the Fund's recipients, an address will gladly be supplied by the secretary.

To those members who have generously responded to our appeals in previous years, we extend our grateful thanks.

Yours faithfully,
H. W. DAWES, *President*.
J. McCUNN, *Hon. Treasurer*.
J. J. DUNLOP, *Hon. Secretary*.

November 28th, 1960.

Surgical Interference in Dilatation of the Stomach in the Dog (Torsion of the Stomach)

Sir,—We were interested in Messrs. Tutt and Yarrow's clinical report on the above subject (November 12th) and in Mr. Steele's letter (November 19th).

We meet on an average perhaps 1 or 2 cases a year, and have seen the condition in a variety of breeds, Great Dane, Borzoi, Boxer, Alsatian, Gordon Setter, Cocker Spaniel and Bedlington Terrier being among them. We have never attempted laparotomy and congratulate the writers on their courage and skill in carrying out this operation so promptly and successfully. A number of our cases have been *in extremis* from suffocation when first seen, and though in most cases we have punctured with a fairly small-bore cannula to relieve pressure, they have invariably died from shock in a matter of hours, but have never become distended again before death.

Where we get a case in the less critical stages we always try to produce vomiting by strong saline orally, as we are of the opinion that the torsion follows, rather than causes, the sudden gas formation. If the saline reaches the stomach and there is vomition the symptoms in these comparatively early cases subside. If the torsion has already occurred and the saline is returned promptly, as with an occluding foreign body in the oesophagus, no harm is done. We do not administer this fluid if respiratory distress has begun.

We have also had success in one early case following the passage of an oesophagoscope into the stomach under thiopentone sodium anaesthesia, bearing in mind that, if torsion were complete, pressure against the twist would cause perforation and the attempt must be abandoned.

The sudden development of the condition suggests a possible allergic cause and the following case history may be of interest. On August 20th, 1957, we were called to a 4-year-old Borzoi bitch with rapidly developing abdominal distension, discomfort but, as yet, no respiratory distress. She had vomited, but we advised the owner to try to massage up gas by mouth until we got there about 15 minutes later, when 2 c.c. of parenteral promethazine hydrochloride* was injected intravenously. Relief of symptoms was fairly rapid, and when seen 3¼ hours later the bitch was normal. Another attack commenced on September 2nd, 1957, and was treated by 4 c.c. of parenteral diphenhydramine hydrochloride† intravenously, followed by quick relief. Capsules of the same drug were given orally for 24 hours. Further attacks were similarly treated successfully by antihistamines on December 2nd, 1957, and October 10th, 1958, two injections being required, at an interval of 9 hours, on the last occasion despite oral administration as usual. About 3 months after this she produced and reared a litter without crisis and remained free from trouble until August 4th, 1959, when she was found *in extremis* one morning, having developed the trouble during the night, and died from shock following gastric puncture to avert suffocation. This is the only case we have had which suffered any subsequent attack having survived an initial one. She was kept on daily charcoal from the second attack. Despite careful investigation we were never able to incriminate any particular food or other factor in producing the condition in just one out of quite a number of dogs kept in the same kennels.

We would certainly now be emboldened to try laparotomy where torsion had gone beyond recall.

We find the insertion of a well-fitting Magill's tube into the trachea a great safeguard in any case in which regurgitation of stomach contents under anaesthetic is a possibility and leave it in until the cough reflex is restored.

Yours faithfully,
CHRISTINE A. WOODS,
MARY DALBY.

Westwick,
Menston,
Nr. Ilkley, Yorks.
November 21st, 1960.

* Phenergan, May & Baker.

† Benadryl, Parke Davis.

Retirement of Mr. F. Knight

Sir,—May UFAW add a very warm tribute to the many which have been so well earned by 35 years of devoted service to the veterinary profession and through that to the animals who owe so much to that profession? At its inception UFAW (then ULAWS) realised that the guidance of veterinarians would be indispensable to its work, and in its frequent contacts with the B.V.A. it has again and again had occasion to feel grateful for the courteous sympathy of the latter's late secretary.

Yours faithfully,
C. W. HUME,
Secretary-General of UFAW.

The Universities Federation for Animal Welfare,
7a Lamb's Conduit Passage,
London, W.C.1.
November 21st, 1960.

A Veterinary Centre

Sir,—Mr. G. N. Henderson's suggestion for a Veterinary Centre worthy of our profession is to my mind outstanding in its vision and foresight.

I should like to suggest that the B.V.A. immediately consider launching a national building campaign for the erection of premises which would not only be a credit to all of us, but a credit to the nation, in

whose economy we now play such a vital part. I realise that this is not a job to be tackled by the R.C.V.S., but I see no reason why the B.V.A. Council could not start such a campaign with the wholehearted blessing of the parent body.

It would indeed be tragic if Mr. Henderson's ideal could not be realised on the grounds of economy, because we must face the fact that even our present inflated capital is hopelessly inadequate for such a project.

Yours faithfully,
E. C. STRAITON.

Veterinary Surgery,
132, Lichfield Road,
Stafford.
November 21st, 1960.

Use of Teoquil for the Treatment of Ringworm in Cattle

Sir,—The wonderful results reported by S. Forenbacher, M. Hajsig and V. Sertic in THE VETERINARY RECORD of November 19th, 1960, are said by them to "appear to confirm the observations made by other workers." Their findings are quite at variance with those of O'Brien and Sellers (1958), McPherson (1959) and our own unpublished findings.

Assessment of the value of therapy in a disease which can disappear spontaneously without treatment has to be very critical. We suggest that our Jugoslav colleagues did not go far enough in ascertaining that there were no relapses or that many animals were recovering spontaneously. They state "when the veterinary diagnosis was made it was reported that the disease had been spreading . . . for several weeks." It was at this point that treatment started. If the firm producing the substance in question encouraged the publication of the Jugoslavian results we suggest that they might also have encouraged reports on control animals in the bovine experiment.

McPherson (1959) has pointed out that the guinea-pig is an unsuitable experimental animal for *Trichophyton verrucosum* because spontaneous recovery is so rapid.

Yours faithfully,
I. M. LAUDER,
J. G. O'SULLIVAN.

University of Glasgow,
Veterinary School.
November 22nd, 1960.

References

O'BRIEN, J. D. P., & SELLERS, K. C. (1958). *Vet. Rec.* **70**. 319.
MCPHERSON, E. A. (1959). *Vet. Rec.* **71**. 539.

The Racing Greyhound

Sir,—May I, through your columns, thank Mr. J. K. Bateman for his letter in your issue of November 12th, in which he replies so fully to my query concerning C.V.H. He has, indeed, been much more definite than I anticipated and it would now be interesting to have the views of colleagues in small-animal practice. Mr. Bateman must be one of the very few who vaccinates against distemper and ignores C.V.H. Our laboratory workers may wish to comment on his last paragraph dealing with *post-mortem* findings.

I note that Mr. Bateman immunises against *Leptospira icterohaemorrhagica* but not against *L.canicola*. What are the reasons for excluding the latter?

I also diagnose tonsillitis in many cases, but I am frankly concerned about a possible virus origin until events prove such cases to be uncomplicated.

Yours faithfully,
J. W. H. HOLMES.

81a, Wantage Road,
Wallingford,
Berks.
November 27th, 1960.

***Teladorsagia davtiani* in British Sheep**

Sir,—Dr. Rose is to be congratulated on his addition of yet another nematode species to our list of parasites of British livestock. As he has stated, apart from the replacement of the accessory bursal membrane by a massive structure with two sessile papillae, it is difficult to differentiate between this species and *Ostertagia trifurcata* and it is certain that a proportion of parasites previously diagnosed as *O. trifurcata* have in reality been *Teladorsagia davtiani*. The following further observations may therefore be of interest.

In Scotland, the parasite has been recovered from sheep and lambs from most of the mainland counties and from the Hebrides. The relative proportions of *T. davtiani* and *O. trifurcata* are extremely variable and the former has been found to constitute between 47 per cent. and 100 per cent. of the *O. trifurcata*/*T. davtiani* group and between 8 per cent. and 19 per cent. of all *Ostertagia* (accepting for the moment the tribal division).

Teladorsagia davtiani has also been recovered from the roe deer (*Capreolus capreolus*) in Scotland, a new host-record for the parasite, additional to the fallow deer (*Dama dama*) (Jansen, 1958) and the original sheep and goat records of Andreeva and Satubaldin (in Skrjabin *et al.*, 1954).

Though the gubernaculum is well-defined there has been observed no evidence of the wings described by the Russian authors, and since its major claim to identity rests on the detail of the genital cone, it is doubtful whether *Teladorsagia* will achieve permanent generic status; this is especially so in view of the existence of several sub-genera of *Ostertagia* with more substantial morphological differences than *Teladorsagia*. Jansen's suggested promotion of these to genera is, however, timely.

Yours faithfully,
ANGUS M. DUNN.

University of Glasgow,
Department of Veterinary Pathology,
The Veterinary School,
85, Buccleuch Street,
Glasgow, C.3.
November 25th, 1960.

References

SKRJABIN, K. I., SHIKHOBALOVA, N. P., & SCHULTZ, R. S. (1954). "Osnovy Nematodologii." Vol III. Moscow.
JANSEN, J. (1958). Thesis, Utrecht.

A New Anti-fungal Agent for Veterinary Use : The Borotannic Complex

Sir,—Mr. P. J. Cautley's article in THE VETERINARY RECORD of September 10th, 1960, states, with reference to cat and dog ringworm, that "methods of treatment in the past have been poor and many pets have had to be destroyed for lack of an adequate mode of therapy." We believe that griseofulvin is an adequate mode of therapy. Mr. Cautley implies that it is not. On present evidence it seems at least the best therapy available.

Yours faithfully,
I. M. LAUDER,
J. G. O'SULLIVAN.

University of Glasgow,
Veterinary School.
November 22nd, 1960.

Depression of Serum Mg. Levels in Ruminants by Vitamin D

Sir,—In a paper presented at the recent B.V.A. Hypomagnesaemia Conference in London (November 23rd and 24th), Dr. Ruth Allcroft indicated that vitamin D is of little or no value in preventing hypomagnesaemic tetany in cattle and sheep. In the subsequent discussion Dr. W. A. Greig stated that in the dairy cow a single dose of about 10 million I.U. vitamin D had produced a marked fall in serum Mg. within about a week. Mr. P. J. Treeby said that in hill sheep a single injection of ½ to 1 million I.U. vitamin D_3 per 100 lb. live-weight produced no such effect during the following 5 months. In reply Dr. Allcroft said that her findings had been similar to those of Mr. Treeby. However, Blackburn *et al.* (1957) produced an appreciable reduction in the serum Mg. of calves by the oral administration of large daily doses of vitamin D_3. This is the only published record of such an effect that I have been able to trace.

These contradictory reports might appear to be due to species differences; but in some recent controlled experiments with Scottish black-faced sheep we have found that the effect on serum Mg. levels produced by a single injection of 400,000 I.U. vitamin D_3 was dependent on circumstances. In an experiment involving age-matched groups of 8 ewes vitamin D_3 administered at the beginning of March to ewes grazing the relatively sunless north side of a hill produced no obvious differences in the serum Mg. levels. Similar treatment of ewes on the south side of the same hill lowered the mean serum Mg. level of the injected group to about two-thirds that of the control group at 2 and at 3 months after injection. In another experiment, on a partly shaded hill grazing, the mean serum Mg. level of treated sheep was reduced 3 months after injection to three-quarters that of the controls when the injection was given in early January but not when it was delayed till the end of March.

These results suggest the possibility that the observed depression of the serum Mg. was a manifestation of vitamin D excess. Whether excessive vitamin D levels were reached would depend firstly on the extent of the animals' natural stores of the vitamin, and secondly on the supplementary dosage rate. With the dose employed excessive levels of vitamin appear to have been reached in those injected sheep which had good natural reserves derived from grazing in full sunshine on the south side of the hill, but not in those on the shady north side where they would have derived relatively much less vitamin D from solar irradiation.

Similarly, it can be argued that those sheep dosed in January would have better natural reserves of vitamin than those dosed in late March, so that supplementary dosage with vitamin D resulted in depression of serum Mg. in the former group but not in the latter.

It should be noted that these experiments followed the brilliantly sunny summer of 1959.

Yours faithfully,
H. S. McTAGGART.

Department of Veterinary Medicine,
Royal (Dick) School of Veterinary Studies,
Edinburgh, 9.
November 26th, 1960.

Reference

BLACKBURN, P. S., BLAXTER, K. L., & CASTLE, E. J. (1957). *Proc. Nutr. Soc.* **16.** (2). xvi.

A Useful Accessory

Sir,—I find the disposable plastic sleeves all that Mr. Jordan claims for them, and used ordinary plastic bags for this purpose before the sleeves became available.

In my opinion the sleeves would be better were they 6 inches longer. It is important that no pressure should be exerted on the sealed end during introduction or it may give way. It seems that they are a potential danger to cows which might eat them, and I make a point of disposing of them so that there is no such risk.

The Ministry of Agriculture recently issued a circular asking that specimens sent for swine fever diagnosis should not be packed in plastic material.

Yours faithfully,
G. W. SERTH.

102, Brighton Road,
Purley,
Surrey.
November 26th, 1960.

Laryngeal Obstruction in the Calf

Sir,—We read with interest Marshall and Watson's observations on laryngeal obstruction in calves.

Since writing the clinical note we have revised some of our opinions. Firstly, we believe that the idea of a calf diphtheria syndrome is untenable and secondly that the condition is more widespread than was suggested. Mr. Edgar, of Wigtown, has since informed us of the disease in his practice.

We agree that no drug has any really beneficial effect.

Marshall and Watson's case, where the larynx was surrounded by a "bloody, gelatinous mass" reminds one of the lesion found in some cases of bracken

poisoning. In their case, where the calf died 3 hours after onset of symptoms, we believe an allergy to have been the cause. Oedema was easily felt in the epiglottis of a calf showing respiratory distress about 1 month ago; this cleared up in 8 hours.

Trauma can also cause similar symptoms. A Friesian bullock, 1½ years old, was examined using a Drinkwater's gag and revealed a "D" shaped wire embedded partly in the larynx and pharynx. When this was removed the symptoms cleared up in 2 to 3 days but if the infection had been deep seated the distress (or symptoms) would have persisted longer.

We have found no age incidence. Of the 5 cases encountered in this practice in the last 2 years the ages of animals affected were 2 months (2), 5 months, 1½ years and 2 years.

Treatment seems to be in the experimental stage. We operated 6 weeks ago on a 1½-year-old Aberdeen Angus cross-bred bullock. This animal showed symptoms after recovering from an attack of bracken poisoning. A permanent tracheotomy tube was designed and inserted. The animal tore this out 4 weeks later, when a horse tube was inserted.

Mr. Edgar uses an 8-inch plastic tube which he inserts and anchors by means of nylon "tails" to the skin. Perhaps a simple method would be to push in a plastic tube until it reaches the bifurcation of the bronchi and leave it protruding 2 inches from the trachea.

We do not think the operation is practical in young calves.

It is, perhaps, worthy of note that in our most recent case, the temperature of the bullock, which had remained in the region of 103° to 104° for 14 days, dropped to normal the day after the operation.

Yours faithfully,
D. SEAWRIGHT,
J. DOYLE.

107-109 Moss Street,
Keith,
Banffshire.
November 14th, 1960.

Meat Inspection

Sir,—Your editorial dated September 10th, 1960, with regard to meat inspection, is very commendable; it has only one fault, that is to say, it is addressed to the wrong people.

It can be safely assumed that the profession is aware of the need for an organised meat inspection system in Great Britain, but the same cannot be said for the general public.

Now that we have a capable public relations officer, it is clearly the duty of the Officers of the B.V.A. to prepare a fresh plan of action for him to bring this matter again to the attention of the general public, through the media of press releases, radio and television.

If the members of the profession feel that full participation in the field of meat inspection is rightfully theirs, then I suggest that a flood of letters to the following addresses will accomplish the desired result:—

The Officers of the B.V.A.—to urge them to prepare a further and wider plan of action for the Association's public relations officer to publicise the facts of the situation.

The President of the R.C.V.S.—to urge him to impress on the Minister of Agriculture the feelings of the profession on this subject, and to work with the B.V.A. as closely as possible in this matter.

Each member to write to his Member of Parliament—asking the latter to approach the Minister of Agriculture with a view to obtaining a reconsideration of the whole unfortunate business.

If requested, I feel sure that many farmers—whom members of the profession meet in their daily business—would be happy to write similar letters to their M.Ps.

Yours faithfully,
J. N. SIMPSON-WHITE.

10504 Walnut Avenue,
South Gate,
California.
November 23rd, 1960.

Correction

We regret a printer's error in Mr. I. H. Pattison's letter last week. On page 1,100, line 19, the first word should have read "dispute," not "disrepute."

ADVERTISER'S ANNOUNCEMENT

C. J. HEWLETT & SON LIMITED wish to advise the veterinary profession that henceforth they will be known as C. J. Hewlett & Son, Division of Astra-Hewlett Limited, King George's Avenue, Watford. This change of name will not affect the Company's rights, obligations or undertakings, and will in no way alter existing policy. The division will continue within the framework of the organisation to be directed and staffed by the same personnel as hitherto.

DISEASES OF ANIMALS ACT, 1950—GREAT BRITAIN
Summary of Returns of Confirmed Outbreaks of Scheduled (Notifiable) Diseases

Period		Anthrax	Atrophic Rhinitis	Foot-and-Mouth	Fowl Pest	Sheep Scab	Swine Fever
1st to 15th November, 1960		6	—	113	100	—	66
Corresponding period in	1959	16	—	—	251	—	75
	1958	2	—	—	25	—	38
	1957	13	1	8	72	—	43
1st January to 15th November, 1960 ...		175	1	143	1,690	—	1,068
Corresponding period in	1959	224	2	9	979	—	1,133
	1958	139	5	116	642	—	1,107
	1957	290	8	125	816	—	852